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85-1279

No.

IN THE

Supreme Court of the United States

OCTOBER TERM, 1985

UNITED NUCLEAR CORPORATION,
KERR-MCGEE CORPORATION,
QUIVIRA MINING COMPANY and
HOMESTAKE MINING COMPANY OF CALIFORNIA,
Petitioners,

v.

ENVIRONMENTAL PROTECTION AGENCY,
Respondent.

APPENDICES TO PETITION FOR A WRIT OF CERTIORARI TO THE UNITED STATES COURT OF APPEALS FOR THE TENTH CIRCUIT

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APPENDIX A

UNITED STATES COURT OF APPEALS
TENTH CIRCUIT

Nos. 83-1014, 83-1041, 83-1206, 83-1300

AMERICAN MINING CONGRESS, UNITED NUCLEAR CORPORATION, HOMESTAKE MINING COMPANY, QUIVIRA MINING COMPANY, KERR-MCGEE CORPORATION, SIERRA CLUB, THE ENVIRONMENTAL DEFENSE FUND, INC., NATIONAL RESOURCES DEFENSE COUNCIL, SOUTHWEST RESEARCH AND INFORMATION CENTER, and JEAN SLATTERY,
Petitioners,

v.

LEE M. THOMAS, Administrator,
Environmental Protection Agency, and
ENVIRONMENTAL PROTECTION AGENCY,
Respondents.

STATE OF COLORADO,
Intervenor.

[Filed Sept. 3, 1985]

Petition for Review of the Standards
Promulgated by the Environmental Protection Agency

Before LOGAN and McWILLIAMS, Circuit Judges, and BOHANON, District Judge.*

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* Honorable Luther L. Bohanon, Senior United States District Judge for the District of Oklahoma, sitting by designation.

LOGAN, Circuit Judge.

These consolidated cases involve challenges to the Environmental Protection Agency's (EPA) standards for the cleanup and disposal of uranium mill tailings originating from designated inactive mill sites. The EPA established these standards pursuant to its authority under the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA), as amended, 42 U.S.C. §§ 2022 and 7901-7942. The UMTRCA required the EPA to promulgate standards that could be applied generally to protect the environment and the public health and safety from radioactive and nonradioactive hazards posed by uranium mill tailings at both active and inactive processing sites. Under the statutory scheme the federal government and the affected state share the costs of the remedial action taken to control mill tailings, *see* 42 U.S.C. § 7917, with the possibility of later reimbursement from private parties, *id.* § 7925. The EPA standards that we review here pertain only to inactive mill sites. In a companion case released this day we review regulations relating to active mill sites. *See American Mining Congress v. Thomas*, —— F.2d —— (10th Cir. 1985) (*Active Sites Case*).

The following parties filed petitions for review of these standards: the American Mining Congress, a trade association; joint petitioners United Nuclear Corporation, Kerr-McGee Corporation, Kerr-McGee Nuclear Corporation, and Homestake Mining Company; joint petitioners Sierra Club, Environmental Defense Fund, Natural Resources Defense Council, Southwest Research and Information Center and Jean Slattery; and the State of Colorado as intervenor. In addition, the State of Wyoming filed an amicus brief.

I

The final product of the milling process for uranium ore is uranium-rich "yellowcake," U_3O_8. The milling process also produces a residue of either slime or coarse sand. This residue, which comprises the uranium mill

tailings piles, contains radioactive material, the most significant of which is radium. Radium decays to produce radon. Radon is an inert gas, some of which escapes from the tailings particles into the atmosphere. Airborne radon degrades into a series of short half-life decay products that are hazardous if inhaled. If the radon gas does not escape the mill tailings piles, its decay products remain in the piles and produce gamma radiation, which may be harmful to people and animals living near the mill tailings piles. Uranium mill tailings also contain potentially dangerous nonradioactive materials such as arsenic and selenium. These toxic and radioactive materials may be ingested with food or water. 48 Fed. Reg. 590, 592 (1983). *See generally* I Environmental Protection Agency, *Final Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites* 3-68 (1982) [hereinafter FEIS-IN].

To deal with the perceived dangers presented by uranium mill tailings, Congress enacted the UMTRCA. When it passed this legislation in 1978, it stated, in a section titled "Congressional findings and purposes":

> "uranium mill tailings located at active and inactive mill operations may pose a potential and significant radiation health hazard to the public, and that the protection of the public health, safety, and welfare . . . require[s] that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings."

42 U.S.C. § 7901(a).

In the UMTRCA, Congress gave the Department of Energy (DOE) and the Nuclear Regulatory Commission

(NRC) responsibility for implementing a remedial program to clean up and dispose of the mill tailings. *See id.* §§ 7911-7924. The EPA is responsible for promulgating the general standards that the implementing agencies must meet. *See id.* §§ 2022(a), 7918(a).

The EPA issued proposed general standards for the remedial program in two parts: cleanup standards and disposal standards. The EPA intended the cleanup standards to reduce the detrimental health consequences of tailings that have been dispersed from the tailings piles or used in construction. 45 Fed. Reg. 27,370, 27,370 (1980). The EPA intended that the disposal standards place the tailings piles "in a condition which will be safe for a long time." *Id.*

On April 22, 1980, the EPA Administrator published for comment "Proposed Cleanup Standards for Inactive Uranium Processing Sites." 45 Fed. Reg. 27,370 (1980). These proposed standards were "for cleanup of open lands and buildings contaminated with residual radioactive materials (mainly tailings) from inactive uranium processing sites." *Id.* The EPA made them immediately effective as interim standards pending comment, review, and promulgation of the final standards. The EPA also issued a draft environmental impact statement to support the proposed standards.

The proposed cleanup standards established allowable levels of radium concentration in soil contaminated by dispersed tailings. The standards also set permissible levels of radon decay product concentration and gamma radiation in occupied or occupiable buildings affected by the tailings.[1]

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[1] The propcsed standard for soil contamination read:

"(a) the average concentration of radium-226 attributable to residual radioactive material from any designated processing site in any 5 cm thickness of soils or other materials on open

In addition, these proposed standards contained exceptions to strict compliance if certain criteria were met. *Id.* at 27,375. At qualifying sites, the implementing agency was to perform remedial action that would come as close as possible to meeting the standard to which the exception applied. *Id.*

The EPA issued the second set of proposed standards, the disposal standards, on January 9, 1981. 46 Fed. Reg. 2556 (1981). The disposal standards placed limits on the radon release to the atmosphere from the tailings piles and also placed limits on water contamination from the piles. *Id.* These standards required that the tailings be disposed of in a manner "that provides a reasonable expectation that these limits will be satisfied for at least one thousand years." [2] *Id.*

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land within 1 foot of the surface, or in any 15 cm thickness below 1 foot, shall not exceed 5 pCi/gm."

45 Fed. Reg. at 27,374. A curie is the amount of radioactive material that produces 37 billion nuclear transformations per second. One picocurie (pCi) = 10^{-12} Ci. *Id.*

The proposed standard for buildings stated that the levels of radioactivity in any occupied or occupiable building shall not exceed, due to residual radioactive materials from any designated processing site, either: (1) 0.015 WL as an average annual indoor radon decay product concentration, including background; or (2) 0.02 milliroentgen/hour of indoor gamma radiation above background. *Id.* at 27,374-75. A WL or working level is "any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts." *Id.* at 27,374.

[2] Specifically, the proposed standard for the radon emission limit from the tailings pile read: "(a) The average annual release of radon-222 from a disposal site to the atmosphere by residual radioactive materials will not exceed 2 pCi/m^2-sec." 46 Fed. Reg. at 2562. A footnote to the standard read:

> "The radon emitted from a tailings site after disposal will come from the tailings and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a disposal plan for each site. . . . After disposal, the radon emission standard is satisfied if the emission rate is less than or equal to 2 pCi/m^2-sec plus the emission rate expected from the disposal materials."

In the proposed disposal standards the EPA left little doubt that it foresaw covering the tailings piles as the most viable means to achieve the proposed radon emission standards. The EPA stated,

> "In the draft EIS we analyze the health and environmental protection benefits and the costs of several levels of controlling tailings, assuming a variety of potential control methods. We find that radon emission levels of an 'average' pile can be reduced to approximately the levels characteristic of ordinary land by applying a soil cover at costs in a range of about 1 to 14 million (1979) dollars."

Id. at 2559.

One of the standards established limits for concentrations of toxic substances in underground sources of drinking water.[3] Another water standard required that sub-

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[3] This standard provides:

"(b) Substances released from residual radioactive materials after disposal will not cause

(1) The concentration of that substance in any underground source of drinking water to exceed the level specified in Table A, or

(2) An increase in the concentration of that substance in any underground source of drinking water, where the concentration of that substance prior to remedial action exceeds the level specified in Table A for causes other than residual radioactive materials. This subsection shall apply to the dissolved portion of any substance listed in Table A at any distance greater than 1.0 kilometer from a disposal site that is part of an inactive processing site, or greater than 0.1 kilometer if the disposal site is a depository site.

Table A

Milligrams/liter:

Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05

[Continued]

stances released from the disposal site "after disposal will not cause the concentration of any harmful dissolved substance in any surface waters to increase above the level that would otherwise prevail." *Id.* at 2562.

The EPA received extensive comments on both the proposed cleanup and disposal standards. *See* II FEIS-IN (summary of comments and responses). The comments were wide ranging—the industry petitioners argued that there was insufficient evidence of risk of harm to warrant the standards, while the environmental groups argued that the proposed standards did not provide adequate protection against the risks posed by the tailings. Both sides buttressed their arguments with technical studies and expert analysis.

Congress in 1982 discussed amendments to the UMTRCA to extend the deadline for the promulgation of final standards and enacted an amendment on January 4, 1983. *See* Act of Jan. 4, 1983, Pub. L. No. 87-415, sec. 18, 96 Stat. 2067, 2077 (1983) (codified at 42 U.S.C. § 2022(a)) (generally referred to as the "1982 amendment"). Anxious to institute standards for the mill tailings, Congress also provided that should the EPA miss the extended deadline, remedial action would com-

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[3] [Continued]

Lead	0.05
Mercury	0.002
Molybdenum	0.05
Nitrogen (in nitrate)	10.0
Selenium	0.01
Silver	0.05
pCi/liter:	
Combined radium-226 and radium-228	5.0
Gross alpha particle activity (including radium-226 but excluding radon and uranium)	15.0
Uranium	10.0"

46 Fed. Reg. at 2562-63.

mence using the proposed standards. *Id.*; House Conf. Rep. No. 884, 97th Cong., 2d Sess. 44-45, *reprinted in* 1982 U.S. Code Cong. & Ad. News 3603, 3614-15. By the time Congress passed the amendment its specified deadline for inactive sites had already passed. *See* 42 U.S.C. § 2022(a). Important for our purposes is that Congress also included in the 1982 amendment a sentence explaining the various factors that it required the EPA to consider in developing the standards: "In establishing such standards, the Administrator shall consider the risk to the public health, safety, and the environment, the environmental and economic costs of applying such standards, and such other factors as the Administrator determines to be appropriate." *Id.*

On January 5, 1983, one day after Congress passed the amendment, the EPA promulgated the final "Standards for Remedial Actions at Inactive Uranium Processing Sites," which covered both cleanup and disposal requirements. 48 Fed. Reg. 590 (1983) (filed Dec. 30, 1982) (codified at 40 C.F.R. §§ 192.00-.43 (1984)). The final regulations differed, in some ways quite substantially, from the proposed standards. In explaining the changes in general terms the EPA said:

> "In response to comments on the proposed standards for disposal and for cleanup, we have evaluated a number of alternatives in terms of their costs and the reductions achievable in potential health effects. A number of changes have been made, including raising some of the numerical limits and eliminating some requirements. The purpose of most of these changes is to make implementation easier and less costly. The changes should not result in any substantial loss of health or environmental protection over that which would have been provided by the proposed standards."

48 Fed. Reg. at 590.

After specifically explaining in a table the various alternatives it had considered for disposal of the mill

tailings piles, the EPA divided the alternatives into categories of least cost, optimized cost-benefit, or nondegradation alternatives. *Id.* at 591. To justify the less stringent final disposal standards, the EPA said that the original standards it had proposed were close to nondegradation standards and that they would have been difficult to implement because they required cleanup and control limits close to background levels of radiation. *Id.* It also said that "the small incremental health benefits, when compared to the benefits for less stringent alternatives, do not appear to justify the large additional costs." *Id.* In its final standards, the EPA purported to select an "optimized cost-benefit" rather than a "least cost" alternative. *Id.* The final standard for control or disposal of the tailings piles set the radon emission limit at 20 pCi/m^2s rather than the proposed 2 pCi/m^2s limit.[4] *Id.* Furthermore, the EPA changed the flat 1000 year disposal longevity requirement, qualifying it with the language, "to the extent reasonably achievable and, in any case, for at least 200 years, ..." 40 C.F.R. § 198.02(a) (1984).

The final regulation set the cleanup standard for land, the maximum concentration level of radium 226, at 5

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[4]

"§ 192.02 Standards.

Control shall be designed to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

(1) Exceed an average release rate of 20 picocuries per square meter per second, *or*

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter."

40 C.F.R. § 192.02 (1984) (footnotes omitted) (emphasis in original).

pCi/gram averaged over the first 15 centimeters of soil and at 15 pCi/gram for soil layers more than 15 centimeters below the surface.[5] This standard was an increase from the 5 pCi/gram level set out in the proposed standard for subsurface soil. 46 Fed. Reg. at 2562. After explaining the differences between the proposed and final regulations for dispersed tailings contaminating the soil, the EPA stated that it believed the final standards "will result in essentially the same degree of cleanup, and will be simpler to implement." 48 Fed. Reg. at 600.

The EPA also adjusted the final standards on the limits for radioactivity in buildings affected by the mill tailings. The EPA increased the maximum permissible level of radon decay product concentration from 0.015 WL to 0.03 WL, requiring, however, that "reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL." 40 C.F.R. § 192.12(b)(1) (1984). The level of gamma radiation allowed by the final standards is no more than 20 microroentgens per hour over background level. *Id.* § 192.12(b)(2).

Commenting upon the difficulty of assessing water contamination at the various sites and stating a belief that there was a low probability of additional contamination

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[5]

"§ 192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, *as a result of residual radioactive materials from any designated processing site*:

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than—

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface."

40 C.F.R. § 192.12 (1984) (emphasis in original).

at most sites, the EPA retreated from its proposed water regulations, stating that it was refusing to enact general regulations on the subject. 48 Fed. Reg. at 599. The EPA, however, did recognize the potential for site-specific water contamination problems. In the cases where there was a potential for ground water contamination, the EPA declared that it had provided:

> "in the implementation section of these standards, that judgments on the possible need for monitoring or remedial actions should be guided by relevant considerations described in EPA's hazardous waste management system, and by relevant State and Federal Water Quality Criteria for existing and anticipated uses of the aquifer."

Id. at 599-600. The EPA adopted the same approach to surface water contamination, leaving the regulatory burden to the DOE and the NRC on a site-specific basis, although it indicated that it thought surface water would be adequately protected in any case by its general disposal standards. *Id.*

The final standards, like the proposed standards, incorporated provisions allowing the implementing agency to grant exceptions if certain criteria were met. *See* 40 C.F.R. §§ 192.21-.22 (1984).

The industry petitioners, the environmental groups, and the State of Colorado raise the following issues for our consideration: (1) whether the EPA must find that the mill tailings piles present "a significant risk" of harm before promulgating standards under the UMTRCA; (2) whether the EPA's radon emission and radium-in-soil standards are invalid because they are on-site standards beyond the EPA's authority to promulgate; (3) whether the EPA standards unlawfully impose management, design, and engineering requirements; (4) whether the EPA should engage in a cost-benefit analysis in establishing the standards for the final regulations, particu-

larly the radon emission standard; (5) whether the EPA's standards for the mill tailings piles are arbitrary and capricious because they are unsupported by the record and bear no rational relationship to the protection of the public safety and health and the costs required to implement them; and (6) whether by abandoning general water quality standards and standards regarding non-radiological toxic pollutants the EPA has acted contrary to the law.

The UMTRCA refers to the Administrative Procedure Act, 5 U.S.C. §§ 701-706, for standards of judicial review of rules promulgated under it. *See* 42 U.S.C. § 2022(c)(2). The appropriate standard of review for this type of informal, notice and comment rulemaking is that an agency's action may be set aside if found to be "arbitrary, capricious, an abuse of discretion, or otherwise not in accordance with law," 5 U.S.C. § 706(2)(A). The Supreme Court recently has reiterated a restrictive view of the arbitrary and capricious standard, stating:

> "The scope of review under the 'arbitrary and capricious' standard is narrow and a court is not to substitute its judgment for that of the agency. Nevertheless, the agency must examine the relevant data and articulate a satisfactory explanation for its action including a 'rational connection between the facts found and the choice made.' . . . In reviewing that explanation, we must 'consider whether the decision was based on a consideration of the relevant factors and whether there has been a clear error of judgment.' . . . Normally, an agency rule would be arbitrary and capricious if the agency has relied on factors which Congress has not intended it to consider, entirely failed to consider an important aspect of the problem, offered an explanation for its decision that runs counter to the evidence before the agency, or is so implausible that it could not be ascribed to a difference in view or the product of agency expertise."

Motor Vehicle Manufacturers Ass'n v. State Farm Mutual Automobile Insurance Co., 463 U.S. 29, 43 (1983) (citations omitted). In addition, as part of our review, we also determine: (1) whether the agency acted within the scope of its authority, and (2) whether the agency complied with the prescribed administrative procedures. *See Citizens to Preserve Overton Park, Inc. v. Volpe*, 401 U.S. 402, 415-17 (1971); *American Petroleum Institute v. EPA*, 540 F.2d 1023, 1028 (10th Cir. 1976), *cert. denied*, 430 U.S. 922 (1977); 5 U.S.C. § 706(A)(2)(C) & (D).

II

A preliminary question arises as to what documents we may review in considering these petitions. The EPA, supported by the environmental petitioners, has moved to strike references in the briefs filed by industry petitioners to documents and reports not in the record. Industry petitioners not only allege that those items are proper for our consideration but have moved to supplement the record to include the documents and reports that they cite. A decision on the appropriate use of these materials is important, because, in this case, we are a reviewing body, not an independent decision maker. We do not substitute our judgment for the judgment of the agency simply because we might have decided matters differently. We agree with the comments in *Deukmejian v. Nuclear Regulatory Commission*, 751 F.2d 1287, 1323-1326 (D.C. Cir. 1984), that the agency's action must be reviewed on the basis articulated by the agency and on the evidence and proceedings before the agency at the time it acted. Aggressive use of extra-record materials also would run directly counter to the admonitions of the Supreme Court in *Motor Vehicle Manufacturers Association.*

Thus, any exception to this general rule against the use of extra-record materials must be extremely limited. Nevertheless, a few courts have found exceptions. A

recent law review article discusses the problem that we, and all other appellate courts, face in determining whether and how to use extra-record citations. Stark & Wall, *Setting No Records: The Failed Attempts to Limit the Record in Review of Administrative Action*, 36 Ad. L. Rev. 333, 335 (1984). The article notes that, on review, parties have offered extra-record studies and other evidence under a number of justifications, including (1) that the agency action is not adequately explained and cannot be reviewed properly without considering the cited materials, *see Citizens to Preserve Overton Park, Inc. v. Volpe*, 401 U.S. 402, 420 (1971); (2) that the record is deficient because the agency ignored relevant factors it should have considered in making its decision, *see Hiatt Grain & Feed, Inc. v. Bergland*, 446 F. Supp. 457, 467 (D. Kan. 1978), *aff'd on other grounds*, 602 F.2d 929 (10th Cir. 1979), *cert. denied*, 444 U.S. 1073 (1980); (3) that the agency considered factors that were left out of the formal record, *see Environmental Defense Fund, Inc. v. Blum*, 458 F. Supp. 650, 661 (D.D.C. 1978); (4) that the case is so complex and the record so unclear that the reviewing court needs more evidence to enable it to understand the issues, *see Bunker Hill Co. v. EPA*, 572 F.2d 1286, 1292 (9th Cir. 1977); and (5) that evidence coming into existence after the agency acted demonstrates that the actions were right or wrong, *see American Petroleum Institute v. EPA*, 540 F.2d 1023, 1034 (10th Cir. 1976), *cert. denied*, 430 U.S. 922 (1977). As Stark and Wall observe, when such justifications are offered the court is forced as a practical matter to examine the material, whether or not motions to supplement the record are granted. 36 Ad. L. Rev. at 343-44.

In the instant case one or more of the above justifications are advanced with respect to virtually all extra-record citations. We have in fact considered those materials to see if they fall within any of these possible justifications. But the fact that we examine these materials for the limited purposes set forth above does not

mean that the cited items should become a part of the record in these cases. The references to such extra-record items, we believe, are substantially akin to the practice of citation to scientific treatises in ordinary civil cases. Therefore, we deny the EPA's motion to strike the references; but we also deny all motions to supplement the record except the EPA's unopposed motion to supplement the record with a letter of transmittal dated June 8, 1983, from Christopher Herman of the EPA to Larry Boggs, counsel for petitioner American Mining Congress and two accompanying memoranda dated April 27, 1983, and June 7, 1983.

III

The industry petitioners [6] contend that the language and legislative history of the UMTRCA require the EPA to find that the mill tailings piles pose a "significant risk" before the EPA may promulgate regulations dealing with the mill tailings piles. Petitioners rely on *Industrial Union Department, AFL-CIO v. American Petroleum Institute*, 448 U.S. 607 (1980) (hereinafter the *Benzene* case). In the *Benzene* case, Justice Stevens, for the plurality, invalidated OSHA regulations intended to protect workers from the carcinogenic effects of benzene. Justice Stevens and three other members of the Court agreed that under §§ 3(8) and 6(b)(5) of the Occupational Safety and Health Act,[7] before the Secretary may promulgate any permanent standards for workers' health and safety, he must find that their workplace presents a significant risk of harm. *Id.* at 642. In so concluding, the plurality relied heavily upon the actual language from §§ 3(8) and 6(b)(5). *Id.* at 641-42.

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[6] In the text of this opinion we refer to American Mining Congress, United Nuclear Corporation, Kerr-McGee Corporation, Kerr-McGee Nuclear Corporation, and Homestake Mining Company as the "industry petitioners." Although we recognize that some of their arguments differ, most do overlap.

[7] 29 U.S.C. §§ 652(8) and 655(b)(5).

We believe that the *Benzene* case and all the other OSHA cases requiring a threshold finding of significant risk are readily distinguishable from the case at hand. In the UMTRCA Congress commanded the EPA, the NRC, and the DOE to deal with the problems posed by uranium mill tailings:

> "The Congress *finds* that uranium mill tailings located at active and inactive mill operations may pose a potential and significant radiation health hazard to the public, and that the protection of the public health, safety, and welfare and the regulation of interstate commerce *require* that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings."

42 U.S.C. § 7901(a) (emphasis added). It would be disingenuous to hold, after reading Congress' own statement of its findings and purposes, that the EPA must make its own determination of whether radon emissions present a risk significant enough to warrant regulation under the UMTRCA. Admittedly, the language "may pose a potential and significant radiation health hazard to the public" might lead one to question whether Congress was resolute on the degree of danger the mill tailings pose. Yet, even if Congress was unsure of the absolute risk posed by mill tailings, it was sure of its desire to stabilize and dispose of the tailings and that "every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner . . . ." *Id.*

The legislative history of both the UMTRCA and its 1982 amendment confirm our belief that it is unnecessary for the EPA to make its own determination that the tailings pose a significant risk. The House Report on the

UMTRCA stated, "[a]s a result of being for all practical purposes, a perpetual hazard, uranium mill tailings present the major threat of the nuclear fuel cycle." H.R. Rep. No. 1480, Part 1, 95th Cong., 2d Sess. 11, *reprinted in* 1978 U.S. Code Cong. & Ad. News 7433, 7433. Thus, Congress considered the mill tailings a hazard, despite evidence brought before it that mill tailings might not pose an immediate danger to current generations. In part two of the same House Report the NRC Chairman, Dr. Joseph M. Hendrie, described how the mill tailings piles present a hazard to the public health:

> "Unlike high-level radioactive waste from the back end of the nuclear fuel cycle, which contains products of the fission reaction, mill tailings contain only naturally occurring radioactive elements, in small quantities. . . .
>
> The health effects of this radon production are tiny as applied to any one generation, but the sum of these exposures can be made large by counting far into the future, large enough in fact to be the dominant radiation exposure from the nuclear fuel cycle."

Id. at 25, 1978 U.S. Code Cong. & Ad. News at 7452. By including such passages in its report, Congress showed it was clearly aware that the mill tailings themselves did not pose an immediate grave danger to persons in being. Nevertheless, Congress chose to consider protecting future generations by enacting the UMTRCA and requiring the immediate stabilization and disposal of those tailings.

The 1982 amendments did not change the thrust of the original UMTRCA plan. The changes in the legislation that pertained to the EPA's duties under the UMTRCA, according to the House Conference Report, were not designed to change the EPA's basic regulatory approach. House Conf. Rep. No. 884, *supra*, at 47, 1982 U.S. Code Cong. & Ad. News at 3617. Instead, Congress designed the amendments to set out the factors that the EPA

should consider in developing the standards. The Conference Report indicated that Congress did not find fault with the EPA's proposed standards.

> "In each instance, the conferees have agreed to include specific references in the appropriate sections of the Atomic Energy Act directing EPA and NRC, in promulgating such standards or regulations, to consider the risk to the public health, safety, and the environment, the environmental and economic costs of such standards of [sic] regulations, and such other factors as EPA or NRC, respectively, determine to be appropriate.
>
> . . . The conferees note that this language reflects accurately the current regulatory approach of the agencies. The language agreed to by the conferees should not result in any delays in establishment of remedial action standards. EPA, for example, has already advised the conferees that it is considering costs in formulating its inactive site requirements. . . . Moreover, in adopting the language, the conferees intend neither to divert EPA and NRC from their principal focus on protecting the public health and safety nor to require that the agencies engage in cost-benefit analysis or optimization.
>
> The conferees are of the view that the economic and environmental costs associated with standards and requirements established by the agencies should bear a reasonable relationship to the benefits expected to be derived. This recognition is consistent with the accepted approach to establishing radiation protection standards, and reflects the view of the conferees that, in promulgating such general environmental standards and regulations, EPA and NRC should exercise their best independent technical judgment in making such a determination. At all times, the conferees fully intended that EPA and NRC recognize as their paramount responsibility protec-

tion of the public health and safety and the environment."

Id.

In this conference report there was no mention of the necessity of finding "significant risk" before promulgating regulations. We believe it would be outside the appropriate bounds of judicial review for us to require a showing of significant risk when Congress has been clear in its approval of the EPA's approach to mill tailing regulation.[8]

---

[8] Two discussions, one in the House and one in the Senate, on the conference report may imply that the EPA should make a determination that it must find that radon presents a significant risk. In one, Congressman Lujan stated:

> "In addition, the conferees' action is intended to lay to rest suggestions, such as those made by EPA officials to mill operators in my State, that the preamble to the Mill Tailings Act represents a congressional predetermination that a significant risk exists from radon from mill tailings or that particular forms of remedial action must be taken.

128 Cong. Rec. H8816 (daily ed. Dec. 2, 1982).

In the other, Senator Simpson, the bill's floor manager, discussed the significance of risks with Senator Wallop.

> "Mr. WALLOP: . . . It is my understanding that EPA and NRC have stated that they felt compelled by the Mill Tailings Act to impose stringent requirements, such as a 2-picocurie radon emanation standard, irrespective of costs, because of language in the preamble to the 1978 Mill Tailing Act. From my reading of the applicable provision, the 1978 act directed the agencies to take 'every reasonable effort' necessary to protect public health. Implicit in that language is a direction to exercise reasonable discretion. Have [sic] the amendment dispelled the misapprehension of the agencies on this point? Mr. SIMPSON: I say . . . that, in my best estimate, they have. The statement of [the] managers clearly states that it is the agreement of the conferees that EPA and NRC, in promulgating standards and regulations, should exercise their best independent technical judgments. The agencies should determine the risks associated will [sic] mill tailings and the significance of those risks. They should also examine various

IV

The industry petitioners argue that the EPA's radon "flux" or emission limits and radium-in-soil cleanup standards exceed the EPA's statutory authorization because they operate inside the mill tailings sites. This

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regulatory approaches to deal with significant risks that are identified. Of course, we expect the approach ultimately adopted to be reasonably related to the risks in terms of costs. In short, Congress has not directed any specific regulatory program. On technical issues relating to the regulation of mill tailings, EPA and NRC should both exercise reasonable judgment on the appropriate course to accomplish the basic purpose of the act, which is to protect the public health and safety from unreasonable risks."

128 Cong. Rec. S13,055-56 (daily ed. Oct. 1, 1982).

We recognize the assistance in interpretation that these discussions of the amendments provide. We are constrained, however, by the language of the UMTRCA and the conference report to find that no showing of significant risk is necessary. A colloquy between two House or Senate members cannot change the conference report, it merely is of assistance in interpreting it. *See* Remarks by Congressman Udall, 128 Cong. Rec. H8824 (daily ed. Dec. 2, 1982) (". . . we cannot with a colloquy change the law. We cannot change the conference report. We can indicate what it means and how it is interpreted by Members who served on it."). To hold that the EPA must determine that the tailings piles pose a significant risk before regulating would change the entire structure of the statute.

It is more reasonable to interpret the quoted comments to mean that the EPA must consider the significance of the risk in weighing the costs and benefits of the alternative standards, a subject we discuss in Part VI. We do not believe that Congress intended the UMTRCA to require the EPA to go through a two-phase analysis of: (1) determining the significance of risk of radon emissions before regulating, and (2) after a significance finding, balancing the costs of the regulations against the benefits (reductions of risks, among other things) of the alternatives. The language of the statute itself and the legislative history of the statute and the amendment are too clear on the need for regulations concerning uranium mill tailings for us to interpret the statute to require a significant risk finding before regulating. Instead, we believe that the alternative that the EPA selects for regulating the piles should reflect the significance of the risk that it believes the piles present.

argument that the EPA may not adopt standards that operate at the mill tailings sites derives from the 1970 Reorganization Plan which transferred the Atomic Energy Commission (now NRC) authority to set generally applicable environment standards to the EPA. *See generally Quivira Mining Co. v. EPA*, 728 F.2d 477, 480 (10th Cir. 1984) (history of reorganization). That act defined standards to mean "limits on radiation exposures or levels, or concentrations or quantities of radioactive materials, in the general environment outside the boundaries of locations under the control of persons possessing or using radioactive material." 84 Stat. 2086, 2088 (1970) (codified at 5 U.S.C. App. § 2(a)(6) at 1132-33). The AEC (now NRC) was to retain authority over the licensing of commercial operations using or producing radioactive materials. 5 U.S.C. App. at 1135.

The American Mining Congress argues that this strict distinction between the EPA operating outside site boundaries and the NRC operating on-site has been maintained in the UMTRCA. The reference to "outside the boundaries," however, does not appear in the final version of § 275 of the UMTRCA. 42 U.S.C. § 2022(b). As finally enacted that statute requires the EPA to adopt only "standards of general application," leaving "implementation and enforcement" to the NRC in the conduct of its licensing activities. *Id.* at § 2022(d). The legislative history and administrative interpretations prior to the promulgation of these regulations are less than clear. Yet Congress' concern all along has been the protection of the general public from radiation and other hazards connected with these operations. *See* House Conf. Rep. No. 884, *supra*, at 47, 1982 U.S. Code Cong. & Ad. News at 3617. If one of the principal hazards is inert radon gas that escapes from a pile into the atmosphere and travels some distance, the obvious remedy is to prevent that escape. Such remedy requires measures applicable at the source. We hold that the EPA has not exceeded its statutory authority in adopting this remedy.

V

The American Mining Congress argues that the radon "flux" or emission limits and radium-in-soil cleanup standards limits are invalid because they influence, and to a great extent define, the type of engineering or design standard to be selected by the implementing agency. *See* H.R. Rep. No. 1480, Part 1, *supra*, at 17, *reprinted in* 1978 U.S. Code Cong. & Ad. News at 7439 ("The EPA standards and criteria should not interject any detailed or site-specific requirements for management, technology or engineering methods . . . on the Department of Energy.").

As noted above, Congress sought in the UMTRCA to divide responsibility for disposal and cleanup among the agencies, with the EPA setting standards for general application and the DOE and the NRC implementing those standards. *See* 42 U.S.C. §§ 7911-7925. This division of responsibility and authority, however, should not be read to prevent the EPA from instituting a radon flux or radium limit that could be translated into a covering measurement requirement. As we discuss in the next section, the EPA had to meet a congressional mandate of some sort of cost-benefit analysis in promulgating the regulations. To do so it had to be able to estimate the cost of implementing the regulations. To determine the cost, the EPA had to have an approximate idea of the type of remedial action that will be undertaken; otherwise, its task is impossible. We therefore hold that the EPA did not exceed its authority by enacting emission limitations that appear to correlate directly with covering measurements. Furthermore, because the standards are general in nature—they apply to all sites—we do not view them as site-specific "management, technology or engineering" methods.

VI

All petitioners criticize the EPA's approach in considering costs and benefits in developing the standards. The industry petitioners find fault with what they describe as the EPA's failure to consider costs of disposal and cleanup in comparison with what they perceive as the limited health benefits of the regulation. The environmental petitioners,[9] on the other hand, argue that the EPA should promulgate strict feasibility standards, with a very limited review of the costs of implementing those standards.

The environmental petitioners argue that the UMTRCA requires the EPA to protect the public health to the maximum extent possible, constrained only by technical feasibility, and, to some extent economic feasibility. Feasibility analysis, as the Supreme Court has used that term, places a less severe restraint on agency action intended to forestall environmental harm than cost-benefit analysis. *See American Textile Manufacturers Institute, Inc. v. Donovan*, 452 U.S. 490, 507-09 & n.27 (1981). Feasibility analysis and cost-benefit analysis are mutually exclusive approaches. *Id.* at 509. In light of the language of the 1982 amendment to the UMTRCA we must reject the environmental petitioners' argument that control of mill tailings should be as extensive as is capable of being performed. The amendment foreclosed the EPA's use of a feasibility standard in promulgating regulations by requiring the EPA to consider "the environmental and economic costs" of applying the standards. 42 U.S.C. § 2022(a). The legislative history also reveals Congress' intent to forgo a feasibility standard. The conference

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[9] In the text of this opinion we refer to joint petitioners Sierra Club, Environmental Defense Fund, Natural Resources Defense Council, Southwest Research and Information Center, and Jean Slattery as the "environmental petitioners." The arguments of the State of Colorado as intervenor and the State of Wyoming as amicus generally parallel those of the environmental petitioners.

report noted that there should be a reasonable relationship between the environmental and economic costs associated with the standards and the benefits to be derived from them. House Conf. Rep. No. 884, *supra*, at 47, 1982 U.S. Cong. & Ad. News at 3617.[10]

We agree with the industry petitioners that the UMTRCA does require a consideration of costs relative to benefits, a cost-benefit analysis,[11] by requiring a reasonable relationship between costs and benefits. We have no doubt, after reading the UMTRCA and its legislative history, that Congress gave the EPA a clear indication of its intent to require some sort of cost consideration. *See American Textile Manufacturers, Inc.*, 452 U.S. at 510-11.

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[10] Also, discussing the amendments in the Senate with Senator Schmitt, Senator Simpson rejected feasibility analysis for these regulations:

> Sen. Schmitt: "By requiring a consideration of environmental and economic costs, is my understanding correct that the Senator wants the regulatory agencies to consider more than just the feasibility of their standards and regulations?
>
> Mr. SIMPSON. The Senator's understanding is correct. The direction to consider costs requires more than a perfunctory determination of whether a given cost can be borne by the uranium industry or a particular licensee."

128 Cong. Rec. S13,055 (daily ed. October 1, 1982).

[11] Senator Simpson indicated that the amendment to the statute did not require an "itemized cost-benefit approach." He stated:

> "As indicated in the statement of managers, standards and requirements must bear a reasonable relationship to the expected benefits; that is, the costs to comply should be commensurate with the risks. This is not to say that an itemized cost-benefit optimization approach is required. In balancing costs and risks to assure a reasonable relationship between the two, judgment must be exercised by the agencies."

128 Cong. Rec. S13,055 (daily ed. Oct. 1, 1982) (colloquy between Sen. Simpson and Sen. Schmitt).

Nevertheless, although Congress acknowledged a cost-benefit requirement, it did not define what the EPA must do to meet that requirement in promulgating regulations. The label "cost-benefit analysis" encompasses everything from a strict mathematical balancing formula to a less strict standard that merely requires the agency to recognize both the costs and benefits of specific proposed alternatives and consider the differences in choosing an appropriate alternative. "Labels are neither important nor determinative." *American Petroleum Institute v. EPA*, 540 F.2d 1023, 1037 (10th Cir. 1976), *cert. denied*, 430 U.S. 922 (1977).

We read the UMTRCA to provide that the EPA must consider the costs involved in the regulations and, with the guidance of Congress' intent, find that these costs bear a reasonable relationship to the benefits derived. *See* House Conf. Rep. No. 884, *supra*, at 47, 1982 U.S. Code Cong. & Ad. News at 3617. The EPA must consider Congress' intent to protect the public health and safety and the environment in its decision, because this intent refines the cost-benefit standard by assigning the values or weights that the EPA must use in its determination of a balance of benefits and costs. *Id.* (Congress considered protection of these things to be "paramount"); *see generally American Petroleum Institute*, 540 F.2d at 1028 ("the guiding star is the intent of Congress . . . . All issues must be viewed in the light of that intent."). The EPA labeled its final standard for control of the tailings piles as an "optimized cost-benefit" alternative. 48 Fed. Reg. at 591. The legislative history of the statute specifically stated that an optimized cost-benefit analysis was not necessary. It also stated that even a cost-benefit analysis was not required.

In the House Conference Report, discussing the 1982 amendment, it states,

> "The language agreed to by the conferees should not result in any delays in establishment of remedial

> action standards. EPA, for example, has already advised the conferees that it is considering costs in formulating its inactive site requirements. . . . Moreover, in adopting the language, the conferees intend neither to divert EPA and NRC from their principal focus on protecting the public health and safety *nor to require that the agencies engage in cost-benefit analysis or optimization.*"

House Conf. Rep. No. 884, *supra*, at 47, *reprinted in* 1982 U.S. Code Cong. & Ad. News at 3617 (emphasis added). The topic sentence of the next paragraph states, however, that "[t]he conferees are of the view that the economic and environmental costs associated with standards and requirements established by the agencies should bear a reasonable relationship to the benefits expected to be derived." *Id.* This language, in the context of the entire legislative history of the 1982 amendments, *see infra* notes 10 and 11, convinces us that Congress intended cost-benefit analysis, but less strict than an optimized cost-benefit analysis.

VII

We must examine each standard to determine whether the EPA properly considered in its analysis each factor required by Congress. Moreover, we must determine whether the EPA's record supports the EPA's action. *See Ethyl Corp. v. EPA*, 541 F.2d 1, 36 (D.C. Cir.) (en banc), *cert. denied*, 426 U.S. 941 (1976).

A

The industry petitioners criticize the EPA's change in and justification for: its radon emission standard (allegedly from a risk of lung cancer to a risk of misuse); its linear-nonthreshold calculations of radon risk; and its projected life-savings from the promulgation of the regulations. They also criticize the insubstantial benefits

of the regulations, which they say bear no rational relationship to their substantial costs.

We do not believe that misuse is an unreasonable justification for the standard, particularly in light of the fact that misuse of the tailings helped lead to the enactment of the UMTRCA. *See* H.R. Rep. No. 1480, Part 1, *supra*, at 11, 1978 U.S. Code Cong. & Ad. News at 7434.[12] We do not believe that the EPA shifted its justification for the radon standard in a manner that denied any party the opportunity to comment on the alleged newly asserted justification, misuse of tailings. In its description of the proposed standard for "Control of Tailing Piles" the EPA stated: "Many interrelated factors affect the long-term performance of tailings pile disposal methods. They include external natural phenomena, such as earthquakes, floods, windstorms, and glaciers, internal chemical and mechanical processes, and *human activities*." 46 Fed. Reg. at 2558 (emphasis added). Thus, given the legislative history of the Act and the EPA's own language in the proposed standards, misuse, as a justification for the standards, was sufficiently foreshadowed in the proposed scheme; the parties here were not deprived of notice or an effective opportunity to respond. *See Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 547 (D.C. Cir. 1983); *Beirne v. Secretary of Department of Agriculture*, 645 F.2d 862, 865 (10th Cir. 1981).

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[12] The Report stated:

> "From the early 1940's through the early 1970's there was little official recognition of the hazards presented by these tailings. Federal regulation of the industry was minimal. As a consequence, mill tailings were left at sites, mostly in the Southwest, in an unstabilized and unprotected condition. Some of these tailings were used for construction purposes in the foundations and walls of private and public buildings. There, through the concentrated emission of radon gas, the hazard of the tailings and public exposure increased substantially."

H.R. Rep. No. 1480, Part I, *supra*, at 11, 1978 U.S. Code Cong. & Ad. News at 7434.

This court recognizes the industry concerns over the costs that must be incurred to prevent, using the EPA's calculations, approximately 170 to 240 potential lung cancer deaths per century in the United States from uncontrolled mill tailings from all inactive sites. 48 Fed. Reg. at 593; I FEIS-IN at 67. We think there is reasonable authority to support the EPA's method of risk calculation in regard to its potential lung cancer death estimate.[13] *See Reserve Mining Co. v. EPA*, 514 F.2d 492, 507 n.20 (8th Cir. 1975) (en banc) ("Indeed, a number of the disputes involve conflicting theories and experimental results, about which it would be judicially presumptuous to offer conclusive findings.").

The industry petitioners also criticize the EPA's "estimate that people living continuously next to some of the piles may have lifetime excess lung cancer risks as high as 4 chances in 100." 48 Fed. Reg. at 593, 598. They criticize these figures on several bases,[14] arguing that: (1) few people, if any, are subjected to this risk; (2)

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[13] This estimate is based upon a linear nonthreshold theory of radiation danger. This theory presupposes that a linear extrapolation of high dose radiation data yields an accurate estimate of low-level radiation risk. Many question this theory of radiation risk. *See Management of Commingled Uranium Mill Tailings: Hearings Before the Subcomm. on Procurement and Military Nuclear Systems of the House Comm. on Armed Services*, 97th Cong., 2d Sess. 176, 186-87 (1982) (comments on proposed EPA standards). Nevertheless, we believe that, in making policy decisions, the EPA may adopt a linear nonthreshold calculation to compute risks from low levels of radiation. *See* McGarity, *Substantive and Procedural Discretion in Administrative Resolution of Science Policy Questions: Regulating Carcinogens in EPA and OSHA*, 67 Geo. L.J. 729, 733-34 (1979).

[14] The industry petitioners also draw our attention to the fact that uranium tailings sites are a "trivial" source of radon in comparison to natural and agricultural releases. This fact may well be true, but it does not prove that uranium mill tailings sites are not a source of radiation risk that Congress instructed the EPA to address.

the estimate is unreasonable in its assumption that someone would live continuously near a tailings pile; (3) the radon daughter concentrations to which nearby individuals are allegedly exposed, which the EPA listed in the Final Environmental Impact Statement, do not correlate with the radon concentrations in the study the EPA cites; (4) the EPA based the radon measurements on inadequate sampling data; and (5) the risk measurements include background radiation, not just radon from the tailings piles. We address separately these rguments.

The EPA has made a "4 in 100" excess risk of lung cancer calculation for those residing near the inactive sites in its radon risk calculation.[15] This figure defines both the risk created by the inactive mill tailings and the benefit to be derived from instituting the radon emission standard—avoidance of that risk. We believe the evidence in the record reasonably supports this risk estimate figure.

Most of the inactive uranium mill tailing sites are located in rather sparsely populated areas. Congress no doubt was aware of this fact when it enacted the UMTRCA and designated the specific sites to which the regulations would apply.[16] *See* 42 U.S.C. § 7912. There are, however, piles located near cities with sizeable local

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[15] At one point in the text preceding the final regulations, the EPA stated this risk to be about 3 chances in 100. 48 Fed. Reg. at 597. We analyze the risk estimate as 4 chances in 100, however, because that is what the EPA ultimately concluded to be the risk. *Id.* at 593, 598.

[16] The Final Environmental Impact Statement states that:

> "We have estimated local and regional exposure at 6 of the 24 inactive sites (SW81). Although this sample is limited, it includes all important urban sites except Canonsburg, Pa. The remaining piles are in remote areas and collectively have only about one tenth of the local and regional population exposures that these six piles collectively have."

I FEIS-IN at 59.

populations, such as Salt Lake City, Utah, and Grand Junction, Colorado. *See* I FEIS-IN at 60, Table 4-3. In addition, as the EPA points out, population distributions may change, as a consequence exposing more people to the dangers of radon. I FEIS-IN at 59 ("Although we have ignored population changes since 1970, a future increase in population at several of the urban sites seems likely."). Therefore, although we may agree with the industry petitioners that few people are currently exposed to radon from the piles, this fact does not necessarily negate the need for regulation, especially in light of Congress' presumed knowledge regarding the population density in areas surrounding the designated sites.[17]

We also reject industry petitioners' assertion that it is unreasonable that someone would live continuously near a pile. Supposedly rational people in our society continuously expose themselves to risks of greater magnitude than those involved here: workers with nuclear materials, underground coal miners, and many others. Some do it for money, some because they underestimate the risk. Radon emission from these piles will occur for thousands of years unless prevented. Public awareness of the dangers may wane. The industry petitioners' criticism does not undermine the validity of the risk assessment; it only points to the limited number of persons who currently may be subject to the risk.

Industry petitioners are correct that there were some discrepancies between the exposure level estimates used to calculate the risk factor included in the Final Environmental Impact Statement, and the referenced study conducted by consultants Ford, Bacon and Davis Utah, Inc.[18] *See* Letter from Christopher Herman, Attorney,

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[17] *See* 42 U.S.C. § 7912 (processing site designations).

[18] The EPA readily acknowledged the discrepancy in the figures used in Table 4-5 of the Final Environmental Impact Statement. *See* Letter from Christopher Herman, Brief of American Mining Congress, Addendum F. These discrepancies are as follows:

[Continued]

Air, Noise and Radiation Division, United States Environmental Protection Agency, Brief for American Mining Congress, Addendum F. Although these discrepancies alter the risk estimates, we do not think that the deviation is sufficiently significant to render the EPA's upper limit risk estimate to be unsupported by available data. Precision is desirable, yet these discrepancies do not rise to a level that would require invalidation of an estimate as an arbitrary decision.

Industry petitioners criticize the EPA for calculating risk from figures they allege were derived from inadequate sampling data and data that included background levels of radiation, instead of figures based solely on the radon emitted from the inactive sites. We do not find these flaws fatal to the EPA's conclusions. The sampling data compiled by the researchers for the EPA is adequate to support the EPA's estimates.[19] An estimate of

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[18] [Continued]

City	Cited Exposure Level	Recalculated * Exposure Level
Salt Lake City **	0.045 WL	0.04 WL
Grand Junction	0.045 WL	0.04 WL
Durango	0.026 WL	0.02 WL
Rifle ***	0.007 WL	0.0085 WL
Gunnison	0.008 WL	0.007 WL

* These exposure levels are in turn used to calculate absolute and relative risk estimates.

** The EPA suggested that this discrepancy resulted from the change in the equilibrium factor from the Draft to the Final Environmetnal Impact Statement.

*** The EPA also conceded that it overstated the distance from the piles to the nearest residents. It used a figure of 0.5 miles when it should have used 0.1 miles.

[19] The American Mining Congress faults the Ford, Bacon study's radon measurements because the figures are based on "a single 24-hour sample." They contend that because of the "variability of outdoor radon levels measurements must be taken over an extended period of time." They indicate that they would approve of forty-

risk may reasonably include possible background risk—to exclude it could lead to unrealistic assumptions regarding the dangers that the sites do present.

B

The industry petitioners' arguments against the EPA's radium-in-soil concentration standard, 40 C.F.R. § 192.12

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eight hour samples taken at three-week intervals over a twelve-month period.

This argument misrepresents the scope of the Ford, Bacon study. It is true that each of the study's radon measurements in all the various locations at each mill tailings site appears to have extended over a twenty-four hour period. *See, e.g.*, Joint Appendix at 36, 39, 54, 77, 136. Yet it is also true that the EPA consultants used numerous sampling locations at each tailings pile site when they conducted these twenty-four hour measurements. *See e.g., id.* at 36, 41 (fifteen locations in Durango); 54, 62 (eight locations in Grand Junction); 77, 83 (twenty-six locations in Salt Lake City); 136 (three locations at Spook site in Converse, Wyoming). Any statistician would appreciate that larger sample sizes yield more reliable data. But at some point a study must compromise perfection because of cost and limited time and resources. Here the consultants extrapolated their data using models that took into account existing information on the topography, weather patterns, and local climate of each site as well as the current location and configuration of tailings and residue at each site. *See, e.g., id.* at 40, 58-59, 79. We think that in these circumstances such a model was an acceptable substitute for periodic samples taken over an extended period of time. The American Mining Congress does not question the validity of the data which comprised the model. It only questions the methodology.

We are not scientists; we are generalist judges deciding whether the methods used were reasonable. We have not been presented with any reasons to distrust a twenty-four hour sample but not a forty-eight hour sample. Given the other information in the consultants' study about variations in radon release at different hours of the day, *see, e.g., id.* at 39, a cycle covering an entire day and night does not seem arbitrary. Likewise, given information that climate and weather patterns may affect radon release, a model that takes into account variations over an entire year at the particular site seems quite reasonable.

(a) (1984), are similar. They say the standards are invalid because (1) the EPA's assumptions about the likelihood of significant exposures from the concentrations do not support the standard; and (2) the EPA's assumptions about the relationship between radium concentrations in the soil and indoor radon exposure and potential health effects are arbitrary.

As the EPA points out, contaminated soil under or near a building contributes significantly to indoor radon. 48 Fed. Reg. at 600. The EPA admits in the FEIS-IN, and the industry petitioners point out, that the actual exposure to radon from contaminated soil may vary from the levels that the EPA assumed. Even considering the possible inaccuracies of the EPA's assumptions, there is nothing in the record or arguments presented to convince us that the EPA acted arbitrarily or capriciously in promulgating this standard to deal with a significant danger the tailings piles present.

The State of Colorado claims that the EPA provided inadequate notice and opportunity for comment on the one hundred square meter sample area for the radium concentration standard. Although this sort of area designation admittedly could influence the effectiveness of the standard, it is not the sort of change that necessitates a new round of comment.

C

In its final standard the EPA increased the allowable level of indoor radon concentration from 0.015 WL to a maximum level of 0.03 WL, stressing that reasonable effort should be made to achieve a radon concentration level of 0.02 WL. *See* 40 C.F.R. § 192.12(b)(1) (1984). The EPA justified this change on the basis that it would ease implementation of the final standard. *See* 48 Fed. Reg. at 600. It further stated that "the final standard deals adequately with complications introduced by the presence of any high concentration of naturally-occurring

radionuclides, and avoids unnecessary and costly remedial actions that produce only marginal improvements." [20] *Id.*

The environmental petitioners criticize the final standard for allowing an unjustified increase in risk, represented by the changes from the proposed to the final standard. The proposed standards of 0.015 WL had an estimated residual risk of lung cancer of 0.8 in 100. I FEIS-IN at 108, Table 7-1. The "reasonable effort" level of the final standard, 0.02 WL, had an estimated residual risk of lung cancer of 1.3 in 100. *Id.* Contrary to the environmental petitioners' argument, the EPA did evaluate the residual risk of lung cancer of the ceiling level of radon decay product, 0.03 WL including background, by considering a range of levels between 0.0 WL above background and 0.05 WL above background. *Id.* The FEIS-IN shows a residual risk of lung cancer of 5 in 100, which appears to be the top side risk at 0.05 WL above background. Although this is a significant increase in the risk, we cannot say the EPA acted arbitrarily or capriciously or beyond its authority in allowing the higher level and its attendant risk.

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[20] In a claim related to this indoor radon concentration standard, the State of Colorado asserts that the EPA exceeded its authority to set standards of general application and usurped the authority of the states and implementing agencies by allowing the use of sealants, filtration and ventilation devices to provide reasonable assurance of reductions from 0.03 WL to below 0.02 WL. *See* 40 C.F.R. § 192.20(b)(3) (1984). The regulation provides that:

> "Residual radioactive materials should be removed from buildings exceeding 0.03 WL so that future replacement buildings will not pose a hazard [unless removal is not practical--see § 192.21(c)]. However, sealants, filtration, and ventilation devices *may provide reasonable* assurance of reductions from 0.03 WL to below 0.02 WL."

40 C.F.R. § 192.20(b)(3) (1984) (emphasis added). We do not read this language as compelling any particular action; instead we read it as suggesting possible alternatives to reduce radon concentration levels.

D

Accepting the EPA's risk calculation estimates and thus its conclusion that the control of the tailings piles will reduce health risks and provide benefits Congress desired, we must now determine whether there existed a reasonable relationship between the estimated benefits of control of the tailings piles and the costs of providing those benefits. We start with the obvious premise that there can be no reasonable relationship in the abstract. As we indicated earlier, Congress' intent serves to define the reasonableness of any relationship between costs and benefits. Given Congress' admonition that the EPA recognize as its "paramount responsibility protection of the public health and safety and the environment," House Conf. Rep. No. 884, *supra*, at 47, 1982 U.S. Code Cong. & Ad. News at 3617, we review the EPA's adoption of the 20 pCi/m^2/sec radon emission standard.

In the Final Environmental Impact Statement the EPA analyzed the "Benefits Derived From Controlling Uranium Mill Tailings Piles," specifically considering the benefits that would be provided under various remedial alternatives—ranging from "No Standards" to the EPA's originally "Proposed Standard." *See* I FEIS-IN at 99, Table 6-6. The benefits enumerated were: the probable reduction or elimination of human misuse of the tailings after control; the permanence of the controls inhibiting misuse and erosional spreading; the reduction in vulnerability of the site to flooding; the reduction in the residual risk of lung cancer; the deaths avoided; and the surface water protection provided. The alternative the EPA ultimately selected in the final regulations, a 20 pCi/m^2/sec standard,[21] provides significant benefits, meeting Congress' concern that the standard protect the public health, safety, and environment. The selected standard and its

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[21] *See* I FEIS-IN at 128-29 (Alternative B selected).

corresponding control method,[22] *see* I FEIS-IN at 91, according to the Final Environmental Impact Statement, will most likely prevent misuse of the tailings for over a thousand years, prevent erosional spreading for many thousands of years, leave no sites vulnerable to flooding, reduce residual risk of lung cancer by over 95%, avoid 190 deaths in the first 100 years of protection, and protect surface water from contamination for many thousands of years. I FEIS-IN at 99, Table 6-6.

The environmental petitioners criticize the validity of the final radon emission standard for not "preventing or minimizing" diffusion of radon into the atmosphere. *See* 42 U.S.C. § 7901(a) & (b)(1). In the same vein, they also criticize the tenfold increase in the level of emissions permitted by the final standard, an increase from 2 pCi/m^2s to 20 pCi/m^2s. Despite this significant increase, we believe that the EPA, through its final radon standard, has sought to prevent or minimize radon emission, thus meeting the Congress' mandate. *See* I FEIS-IN at 99, Table 6-6, at 101. Given the reduction in risk provided by the final standard, we do not believe that the "tenfold increase" in the level of emissions allowed by the final standard makes that standard unreasonable, even in light of the change. We hold that the final standard is within a zone of reasonableness, *see Small Refiner Lead Phase-Down Task Force*, 705 F.2d at 525, and a logical outgrowth of the proposed standard, *id.* at 547.

All of the petitioners find fault with the EPA's suggested longevity requirement for the final radon emission standard—that the standard control emissions to the extent reasonably achievable, have an effective life of 1000 years, and in any case, for at least 200 years. 40 C.F.R. § 192.02(a) (1984). The industry petitioners con-

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[22] EPA's selected alternative correlates to a three meter earth cover requirement. I FEIS-IN at 91, Table 6-2. In addition Alternative B assumes three of the piles will be moved for flood control reasons. *See id.* at 91; B-16.

sider the thousand-year longevity goal unrealistic. The environmental petitioners consider the reduced two hundred-year minimum inadequate, especially in light of the thousand-year proposed standard. We cannot say the final standard fails to accomplish Congress' goal of long-term stabilization in view of Congress' command to take costs into consideration. The final standard meets Congress' desire to avoid the health risks presented by the tailings piles and provide a remedial program that will result in long-term stabilization of the piles.

Congress stressed that the "remedial action must be done right the first time." H.R. Rep. No. 1480, *supra*, at 40, 1978 U.S. Code Cong. & Ad. News at 7467. Given Congress' expressed desire to have a remedial program that will stabilize the tailings piles and additionally, not require continuous allocations of funds, *id.*, we believe the EPA acted reasonably in promulgating a standard based primarily upon the adoption of a passive measure, an earth covering. The industry petitioners particularly are critical of EPA's refusal to consider remedial measures that are more dependent upon active controls such as "maintenance" and "monitoring" by the implementing agencies. The EPA did consider such an alternative. I FEIS-IN at 102, Alternative E. But it rejected that alternative upon review of the benefits it would provide. *Id.* at 98-104, 128-29. Arguably, EPA could have placed more reliance upon the maintenance and monitoring activities of the implementing agencies. Congress, however, did not require it to do so and instead indicated its preference for a more permanent remedial program. The EPA's understanding of its duty under the statute to rely principally upon passive control is sufficiently rational to withstand our review. *See Chemical Manufacturers Association v. National Resources Defense Council, Inc.*, 53 U.S.L.W. 4193, 4196 (U.S. Feb. 27, 1985).

EPA's cost estimates for remedial action at the mill sites and for off-site cleanup were 158 and 38 million

(1981) dollars, respectively. EPA stated that the DOE had estimated its additional costs for program development and management ("overhead") at 118 million (1981) dollars. The total estimated expenditure was 314 million (1981) dollars. These figures include both cleanup (off-site) and disposal (on-site) costs. 48 Fed. Reg. at 596. We recognize the tremendous costs that this cleanup program represents. Nevertheless, we cannot condemn as arbitrary the EPA's determination that these costs bear a reasonable relationship to the benefits to be provided. In fact, in enacting the UMTRCA Congress was well aware of the potential costs of the program. Assessing the economic impact of the legislation in 1978, the House Report stated:

> "This legislation is not expected to have any significant inflationary impact. Over the next 7 years, 22 tailing sites will be treated at a total cost ranging anywhere from $15 million to $200 million, depending largely upon whether tailings will be treated and stored at their present location or, instead, moved to newly prepared disposal sites. Little of this cost is expected to be incurred during the next 3 years because of the time required to identify and prepare disposal sites. Additional costs may be borne by individual states if new disposal sites are required. But even taking these additional costs into account, the impact of the legislation on inflation and overly [sic] economic performance is expected to be immeasurable [sic]."

H.R. Rep. No. 1480, *supra*, at 47, 1978 U.S. Code Cong. & Ad. News at 7474. We must defer to the EPA's finding of a reasonable relationship between the costs and the benefits of the remedial action program for disposal of the mill tailings at the inactive sites. As we have said before in another context, "[w]e are convinced that EPA made a serious, careful, and comprehensive study of the

costs which compliance will impose . . . . If Congress believes that the cost is too high, it can amend the Act. All we say is that EPA has complied with the statutory mandate." *American Petroleum Institute v. EPA*, 540 F.2d 1023, 1038 (10th Cir. 1976), *cert. denied*, 430 U.S. 922 (1977).

VIII

There is one area in which we agree with some of the petitioners or the intervenor that the EPA standards are not in compliance with the law or are inadequate and require remand.

In its final standards the EPA abandoned its proposed general standards for limits of concentrations of toxic substances in surface and ground water.[23] *See* 48 Fed. Reg. at 591, 594; *see also* 46 Fed. Reg. at 2562 (text of proposed standards). The EPA concluded that potential contamination of surface and ground water should be dealt with on a site-specific basis. 40 C.F.R. § 192.20(a)(2) (1984); *see also* 48 Fed. Reg. at 594 (discussion of final rules). In place of the proposed standard for control of waterborne pollutants the EPA included a guideline, stating that the DOE should assess each site individually and establish any corrective or preventive programs necessary to meet relevant state and federal water quality standards. 48 Fed. Reg. at 591. It stated that those programs should be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act (SWDA), 42 U.S.C. §§ 6901-6986. 48 Fed. Reg. at 591; 40 C.F.R. § 192.20(a)(2) & (3) (1984).

We agree with the environmental petitioners and the State of Colorado that by its actions the EPA violated its duty under the statute. In its proposed regulations the EPA stated that there was a problem with water contamination: "There is evidence of limited ground water contamination at some of the inactive sites, but

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[23] *See supra* note 3.

the prospects for long-term contamination have not been fully assessed." 46 Fed. Reg. at 2560. It then proposed specific standards for water quality generally. *Id.* at 2559-63. In the final regulations the EPA acknowledges there are problems, 48 Fed. Reg. at 593, but states: "We do not believe that the existing evidence indicates that ground water contamination from inactive mill tailings is or will be a matter of regulatory concern." *Id.* at 599. We do not believe that the EPA, in issuing the final regulations, declared that it was wrong before; indeed by stating that potential contamination should be dealt with on a site specific basis, *id.* at 594, it acknowledged that problems exist at some sites.

The draft Environmental Impact Statement gave little indication of the possibility that the EPA would reject the proposed water standards and adopt a "guidance" outline for the implementing agencies, abandoning any attempt at specific numerical limits of toxic elements. The only statement we could find in the draft EIS that could be construed to indicate consideration of an alternative similar to that adopted is this: "The proposed ground water protection standards could be considered too strict if implementing them would be unreasonably costly or if they would be impossible to apply." Environmental Protection Agency, *Draft Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites* 8-8 (1980). The explanation of the proposed water quality standard anticipated possible increases in disposal costs to insure against future ground water contamination, but gave no indication that this possibility would make the proposed standards infeasible. 46 Fed. Reg. at 2560. Many of the comments submitted to the EPA during the comment period after publication of the proposed rules suggested that the EPA abandon its proposed ground water standards. *See, e.g.*, II FEIS-IN at D-36, -37, -44, -45, -46. But, regardless of the tenor of some of the comments, the final "guidance"

standard does not represent a logical outgrowth from the proposed regulations.

In our view when the EPA acknowledged that ground water contamination is a problem at some of the inactive sites, it was required to adopt general standards.[24] The UMTRCA provides that the EPA "promulgate standards of general application." 42 U.S.C. § 2022(a). The EPA was not to adopt "site-specific requirements." H.R. Rep. No. 1480, Part I, *supra*, at 16-17, *reprinted in* 1978 U.S. Code Cong. & Ad. News at 7439. By directing the DOE to follow "relevant" state and federal quality standards consistent "to the maximum extent practicable" with the SWDA, *see* 48 Fed. Reg. at 591; 40 C.F.R. § 192.20(a)(2) and (3) (1984), the EPA was unlawfully delegating to the states or to the DOE its own rulemaking authority or was itself establishing standards that could vary from site to site.

We do not agree, however, with Colorado's argument that an unlawful delegation is involved by the provision of the regulations allowing exceptions from the standards in particular circumstances--permitting the implementing agencies, the NRC and the DOE, to "select and perform remedial actions that come as close to meeting the otherwise applicable standard as is reasonable under the circumstances." 40 C.F.R. § 192.22(a) (1984). So long as general standards are in place, permitting exceptions for special circumstances in which costs might be outrageous or compliance impossible is not an abrogation of the duty to promulgate general standards. A court could determine, if required to do so, the reasonableness of an exception granted in a specific case.

The environmental petitioners also complain that the EPA has a duty to formulate general standards for non-

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[24] Of course, a site with no contamination problems would automatically meet any general requirements the EPA might set without further corrective action.

radiological hazards, toxic chemicals in the uranium tailings, *see* 42 U.S.C. § 2022(a), but has not specifically addressed the subject except in conclusory form:

> "We have reviewed the available data on toxic elements in tailings and improved the FEIS-IN in this respect [Appendix C]. We have concluded that it is reasonable to expect that hazards from toxic elements will be adequately limited if control and cleanup are carried out according to these final standards."

48 Fed. Reg. at 597. We are satisfied that the EPA's general regulations on radon emissions, requiring control of the movement of and probable covering of the tailings adequately deal with the nonradiological hazards of the toxic chemicals, except as they may enter waterways or underground water supplies. If there is a possibility that toxic chemicals will enter underground water supplies or waterways, the statute mandates that the problem be dealt with by general standards. On remand, the EPA will have to treat these toxic chemicals that pose a ground water risk as it did in the active mill site regulations.

IX

We reject all challenges to the regulations except as discussed in Part VIII above. The following regulation, concerning water contamination is set aside: 40 C.F.R. § 192.20(a)(2)-(3) (1984). The case is remanded to the agency for further consideration of that specific provision.

APPENDIX B

UNITED STATES COURT OF APPEALS
TENTH CIRCUIT

Nos. 83-2226, 83-2227, 83-2277, 83-2504, 83-2524, 84-1349, 84-1352, 84-1482

AMERICAN MINING CONGRESS, UNITED NUCLEAR CORPORATION, HOMESTAKE MINING COMPANY, AMAX, INC., SOLAR LOBBY, THE ENVIRONMENTAL DEFENSE FUND, INC., NATIONAL WILDLIFE FEDERATION, SIERRA CLUB, AL MANGAN, CHAUNCEY KEPFORD and JUDITH H. JOHNSRUD,

Petitioners,

v.

LEE M. THOMAS, in his capacity as Administrator of the United States Environmental Protection Agency, and ENVIRONMENTAL PROTECTION AGENCY,

Respondents,

STATE OF COLORADO, *et al.*,

Intervenors.

[Filed Sept. 3, 1985]

Petitions for Review of an Order of the Environmental Protection Agency

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No. 84-1908

UNITED NUCLEAR CORPORATION,
HOMESTAKE MINING COMPANY, and
QUIVIRA MINING COMPANY,
Plaintiffs-Appellants,

v.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
LEE M. THOMAS, and UNITED STATES NUCLEAR
REGULATORY COMMISSION,
Defendants-Appellees.

Appeal from the United States District Court
for the District of New Mexico

(D.C. CIV No. 83-1602 HB)

Before LOGAN and McWILLIAMS, Circuit Judges, a
BOHANON, District Judge.*

LOGAN, Circuit Judge.

I

These consolidated cases involve challenges to the E
vironmental Protection Agency's (EPA) standards g
erning stabilization and control of byproduct materia
primarily mill tailings, at licensed commercial uraniu
and thorium processing sites (the active mill sites). T
EPA established these standards pursuant to its author
under the Uranium Mill Tailings Radiation Control A

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* Honorable Luther L. Bohanon, United States District Judge
the District of Oklahoma, sitting by designation.

of 1978 (UMTRCA), as amended, 42 U.S.C. §§ 2022 and 7901-7942, the same statute that required the EPA to promulgate standards applicable to the inactive mill sites. With the exception of No. 84-1908, jurisdiction in this court is based upon 42 U.S.C. § 2022(c)(2). No. 84-1908 arises out of a district court action in which plaintiffs asserted that the active mill site regulations were promulgated outside the time limits prescribed by the UMTRCA. The district court dismissed the suit on the ground that the exclusive method of review was by petition in the court of appeals under 42 U.S.C. § 2022(c)(2); plaintiffs have appealed that dismissal although they are raising the identical issue regarding timeliness of promulgation under their concurrent petition filed under § 2022(c)(2).

As in the inactive mill site challenges, *see American Mining Congress v. Thomas*, —— F.2d —— (10th Cir. 1985) [hereinafter *Inactive Sites Case*], petitioners may be divided essentially into two categories: (1) the industry petitioners—the American Mining Congress, a trade association; and joint petitioners United Nuclear Corporation (and its subsidiary Quivira Mining Company) and Homestake Mining Company; and (2) the "environmental" petitioners—The Environmental Defense Fund, the National Wildlife Federation, the Sierra Club, the Solar Lobby, Al Mangan, Chauncey Kepford, and Judith Johnsrud. Intervenor, the State of Colorado, aligns itself on most issues with the environmental petitioners. AMAX, Inc. aligns itself with the industry petitioners although it is challenging only the inclusion of molybdenum as a constituent of the nonradiological hazards designated in the ground water portion of the regulations.

The substances to be controlled and the UMTRCA's legislative background have been discussed briefly in the companion case filed this day involving regulations for inactive mill sites. The relevant hazards addressed by the UMTRCA and its legislative history are the same for the active and inactive site regulations, so we need not

repeat that discussion here. *See Inactive Sites Ca* —— F.2d at —— (slip op. part I).

Congress, apparently angered by the EPA's inactio imposed time limits upon the EPA's authority to form late regulations to govern the active mill sites. A 19 amendment to the UMTRCA provided, "If the Admini trator fails to promulgate standards in final form und this subsection by October 1, 1983, the authority of t Administrator to promulgate such standards shall term nate" in favor of the Nuclear Regulatory Commission. 4 U.S.C. § 2022(b)(1). The EPA published proposed stan ards for the active mill sites in the Federal Register April 29, 1983. 48 Fed. Reg. 19,584 (1983). The A ministrator signed final standards on September 30, 198 and apparently released copies to the public on that da The regulations did not appear in the Federal Registe however, until October 7, 1983. 48 Fed. Reg. 45,92 (1983) (codified at 40 C.F.R. § 192.30-.43 (1984)).

The EPA's final standards, except those for groun water, were essentially identical to those adopted for th inactive mill sites. Standards to be applied after the si closure period were to assure control of radiological ha ards "for one thousand years, to the extent reasonabl achievable, and, in any case, for at least two hundre years . . . ." 40 C.F.R. § 192.32(b)(1)(i) (1984). Th final standards also established radon emission limits n to exceed an average release rate of 20 picocuries pe square meter per second (pCi/m²s). *Id.* § 192.32(b)(1 (ii). On-site land that meets the described standard i not subject to the disposal standards elsewhere in th regulations. That described standard, based on the max mum concentration level of radium-226 averaged ove areas of 100 square meters, is the same as that at th inactive mill sites: 5 picocuries per gram (pCi/g) av eraged over the first 15 centimeters of soil and 15 pCi/ for soil layers more than 15 centimeters below the su face. *Id.* § 192.32(b)(2).

The EPA ground water standards for the active mill sites are in two parts: (1) a primary standard applicable to new waste storage areas, including lateral expansions of existing tailings piles, and (2) a secondary ground water protection standard applicable to both old and new piles. *Id.* § 192.32(a)(1)-(2). In almost all circumstances the primary standard would require a liner under new impoundments and lateral extensions capable of preventing migration of waste into the ground and water. *See* 48 Fed. Reg. at 45,940-41 (discussion of § 192.32(a)(1)-(2) requirements). Liners were not required for existing impoundments, even though new waste could be added. *See id.* at 45,931 (discussion of § 192.32(a)(2) requirements). The secondary standard in effect requires that the ground water be protected by reducing the level of toxic materials in the ground water to concentration limits permitted by the Solid Waste Disposal Act (SWDA), 42 U.S.C. §§ 6901-6986. The regulations necessitate monitoring programs. 40 C.F.R. § 192.32(a)(2) (1984). One SWDA requirement of impermeable cover material was altered in the final regulations to permit permeable cover in arid areas where evaporation exceeds precipitation. *Id.* § 192.32(a)(1); *see* 48 Fed. Reg. at 45,940 (discussion of basis for alteration). The standards permit exceptions, with the consent of the EPA, for particular existing piles that cannot meet those standards except at extraordinary cost. 40 C.F.R. § 192.32(a)(2)(iv); *see* 48 Fed. Reg. at 45,941 (discussion of potential exceptions). The standards add molybdenum and uranium to the list of hazardous ground water constituents. 40 C.F.R. § 192.32(a)(2)(i).

For purposes of discussion and analysis we divide the petitioners' contentions into four categories: (1) the allegation that the EPA acted beyond its authority because it did not promulgate the regulations within the time requirements of the statute; (2) those arguments sufficiently common to challenges to both the inactive and

active mill site regulations that they may be answered, at least in part, by reference to the companion *Inactive Sites Case*; (3) the challenges to the ground water regulations; and (4) AMAX, Inc.'s objection to the addition of molybdenum as a constituent of hazardous material in the ground water regulations.

II

Petitioners United Nuclear Corporation, Homestake Mining Company, and Quivira Mining Company (hereinafter United Nuclear) assert that the EPA exceeded its jurisdictional authority because it promulgated these regulations after the statutory deadline. In early 1983 Congress passed an amendment to 42 U.S.C. § 2022(b)(1), which provides as follows:

> "If the Administrator [of the EPA] fails to promulgate standards in final form under this subsection by October 1, 1983, the authority of the Administrator to promulgate such standards shall terminate, and the [Nuclear Regulatory] Commission may take actions under this chapter without regard to any provision of this chapter requiring such actions to comply with, or be taken in accordance with, standards promulgated by the Administrator."

It is apparently undisputed that the Administrator signed the final regulations on September 30, 1983, and made them available to the public on that day. In the preamble to the regulations the EPA stated, "This standard is promulgated on the date signed." 48 Fed. Reg. at 45,946. The agency filed the regulations with the Office of the Federal Register on October 6; they appeared in the Federal Register on October 7, 1983.

The federal district court for the District of New Mexico dismissed a challenge to the regulations' timeliness, holding that judicial review of the rules was vested exclusively in the appropriate court of appeals pursuant

to 42 U.S.C. § 2022(c)(2). We have consolidated the plaintiffs' appeal of that ruling with the various petitions for review of the regulations in the proceeding before us. We agree with the district court that all challenges to rulemaking action of the agency, including assertions that the agency acted in excess of its statutory authority or beyond its jurisdiction, should be initiated in the court of appeals. *See FCC v. ITT World Communications, Inc.*, 52 U.S.L.W. 4507, 4509 (U.S. April 30, 1984). The Administrative Procedure Act authorizes this reviewing court to set aside agency action that is "in excess of statutory jurisdiction, authority or limitation." 5 U.S.C. § 706(2)(C).

Courts considering the statutory periods of limitations for petitions for judicial review of administrative rulemaking, which commonly refer to the date of "promulgation" of rules, *e.g.*, 42 U.S.C. § 2022(c), have held that review petitions are timely if filed within a designated period after publication in the Federal Register. *See Environmental Defense Fund v. Gorsuch*, 713 F.2d 802, 812 (D.C. Cir. 1983); *Laminators Safety Glass Ass'n v. CPSC*, 578 F.2d 406, 408 (D.C. Cir. 1978). Relying principally upon these cases, United Nuclear argues for a uniform interpretation of the word "promulgate" as meaning publication in the Federal Register. Under that interpretation the EPA acted too late and thus beyond its statutory authority.

We agree with those decisions that measure the limitations period for seeking judicial review as beginning on the date of publication in the Federal Register. No doubt many parties affected by a rule first learn of it upon publication in the Federal Register. We believe, however, that "promulgation" does not have a single accepted meaning in all contexts. We agree with the EPA that the purpose of the statutory provision was to compel action by the EPA before October 1, 1983. *See* House Conf. Rep. No. 884, 97th Cong., 2d Sess. 43-45, *reprinted*

in 1982 U.S. Code Cong. & Ad. News 3603, 3613-15. In establishing the deadline discussed here, Congress was actually extending deadlines that the EPA had missed in 1979 and 1980. *See id.* The EPA represents, and the other petitioners do not dispute, that the Administrator signed the rules on September 30, 1983, and released them to the public on that same day. At least one meaning of promulgate is to make public; the EPA's action here effectively achieved that end. We do not think Congress intended to throw away the fruits of EPA's labors simply because it did not *publish* the rule before the end of September. We hold that the EPA met Congress' deadline requirement.

III

Most of the arguments by the various petitioners are substantially identical to those in the consolidated *Inactive Sites Case* decided this day.[1] On the basis of the analysis in that opinion, we again hold:

(a) that a finding by the EPA of a "significant risk" is not a prerequisite to promulgating the regulations (*see Inactive Sites Cases*, —— F.2d at —— [slip op. part III]);

(b) that the EPA may promulgate standards to apply within the boundaries of the mill sites (*see id.* at —— [slip op. part IV]);

(c) that the EPA's standards do not unlawfully impose management, design, and engineering requirements (*see* id. at —— [slip op. part V]); and

(d) that the EPA properly considered cost-benefit factors in establishing standards (*see id.* at —— [slip op. part VI]).

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[1] Some environmental petitioners challenge the EPA's failure to promulgate any regulations controlling radon emissions from the uranium processing itself, as opposed to the end product tailings. This issue was not briefed and is not discussed herein. It has been held in abeyance by court orders requested by the parties pending negotiations between the parties.

Most of the various petitioners' arguments that the EPA's standards for radon emission and radium in the soil are arbitrary and capricious are also sufficiently discussed in the opinion on the inactive site regulations. We need not elaborate on or repeat that discussion here. Some of the figures with which we must deal are different, however, and a few arguments have changed somewhat between the two sets of cases.

In formulating the active site regulations the EPA estimated more potential lung cancer deaths from the active mill site tailings, absent regulation, than from the inactive mill site tailings: 500 deaths versus 170-240 deaths per century. *See* 48 Fed. Reg. at 45,929 (active sites); *id.* at 593 (inactive sites). Although its final regulations for the active sites repeated the 4 in 100 lifetime cancer risk for occupants of houses on tailings in Grand Junction, Colorado—the figure it used in its inactive site calculations—the EPA estimates a 2 in 100 lifetime risk for people living continuously next to "some tailings sites." *Id.* at 45,929. The EPA estimated the cost of active site cleanup at $260 million (1983 dollars) for tailings existing today at licensed sites, but a total of $310 million to $540 million total cleanup cost to the uranium milling industry for all tailings now in existence and to be produced through the year 2000. *Id.* at 45,945. For the standard selected for radon emissions, 20 pCi/m²s, the range of incremental costs per death avoided is estimated from $130,000 (nationwide for 1000 years) to $2.5 million (regionally for 100 years). *Id.* at 45,944-45. *See generally Regulatory Impact Analysis of Final Environmental Standards for Uranium Mill Tailings at Active Sites* 4-1 to 5-39 (detailed EPA costs and benefits discussion). These are significant costs, if the EPA's figures are accurate. But we remain convinced that Congress placed the responsibility for evaluating them upon the EPA without imposing a specific cost-benefit requirement. *See Inactive Sites Case*, —— F.2d at —— [slip op. part VI]. Therefore, the industry

petitioners' arguments that the costs are too high for the benefits gained, and the environmental petitioners' arguments that the industry should be forced to incur the greater costs of standards that would save even more lives, should be addressed to Congress or to the EPA, not to this court. *See American Petroleum Institute v. EPA*, 540 F.2d 1023, 1038 (10th Cir. 1976), *cert. denied*, 430 U.S. 922 (1977). The EPA has considered and responded to both of these complaints in justifying its actions. *See* 48 Fed. Reg. at 45,933; *see also* II Environmental Protection Agency, *Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing* A.3-12 to -14 (1983) (hereinafter FEIS-AC).

In arguing that the EPA acted arbitrarily and capriciously the American Mining Congress relies upon a 1984 report by a subcommittee of the EPA's Scientific Advisory Board which stated that the EPA "has not assembled and presented a risk assessment that provides a clear and adequate statement of the scientific basis for developing standards to regulate airborne radionuclide emissions." Subcommittee on Risk Assessment for Radionuclides, Scientific Advisory Board, U.S. Environmental Protection Agency, *Report on the Scientific Basis of EPA's Proposed National Emission Standards for Hazardous Air Pollutants for Radionuclides* 34 (1984). The EPA objects to our consideration of this report because it was not in existence at the time the EPA issued its final regulations.[2] Also, the EPA points out that this report addressed the agency's proposed standards in a separate rulemaking proceeding under the Clean Air Act,

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[2] The EPA has filed a motion to strike references to extra-record items cited by the various petitioners. The industry petitioners have moved to supplement the record with these additional materials. For the reasons we stated in the *Inactive Sites Case*, —— F.2d at —— [slip op. part II], we deny the motions to strike and also deny all contested motions to supplement the record.

that it was not based upon a review of the agency's record before us, and that the Scientific Advisory Board criticisms were aimed generally at the manner in which the EPA assembled the information for decision-making rather than being critical of the background documents themselves. We do not believe that report requires overturning the instant regulations. The report itself acknowledges that scientists may differ in regulatory philosophy, adopting different approaches to risk assessment.[3]

Industry petitioners also protest strongly that the EPA acted inconsistently in the way these regulations require addressing the risks compared with other regulations promulgated under other acts: *e.g.*, control of radiation from high toxicity waste. We cannot evaluate here all the factors that caused the EPA to adopt a different approach in connection with its rulemaking under other laws, if indeed it did act differently. The record shows that the EPA did consider and respond to this inconsistency complaint. *See* II FEIS-AC at A.3-2 to -4. We are satisfied that the EPA acted consistently in formulating regulations for the inactive and active mill sites—except with respect to the ground water regulations, which we discuss separately in these opinions. That the EPA may be faulted for its rulemaking under other acts is not the

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[3] The report states:

> "[I]n the process of risk assessment, many assumptions must be made. Scientists may be swayed in their choice of assumptions by their underlying regulatory philosophy. The choice of a linear non-threshold dose-response relationship compared to a linear quadratic or other relationship is a good case in point. As evidenced by the National Academy of Science's third report on Biological Effects of Ionizing Radiation (BEIR III), knowledgeable scientists disagree on which dose-response relationship is best."

Subcommittee on Risk Assessment for Radionuclides, Scientific Advisory Board, U.S. Environmental Protection Agency, *Report on the Scientific Basis of EPA's Proposed National Emission Standards for Hazardous Air Pollutants for Radionuclides* 7.

kind of internal inconsistency we found to be arbitrary and capricious in *Squaw Transit Co. v. United States*, 574 F.2d 492, 495-96 (10th Cir. 1978).

The American Mining Congress and the State of Colorado make somewhat different arguments that a 5 pCi/g radium standard for land adjacent to a tailings pile is inconsistent with the radon emission standard of 20 pCi/m²s on the pile itself. *See* 40 C.F.R. § 192.32(b) (separate standards listed). We accept the EPA's answer that there is no inconsistency and that the radium cleanup standard was designed to push concentrations in the land sufficiently low to allow unrestricted use, contrary to treatment of the tailings piles. *See* 48 Fed. Reg. at 45,947; II FEIS-AC at A.5-33.

IV

The EPA adopted a two part ground water standard for active mill sites. 40 C.F.R. § 192.32(a)(1)-(2). The primary standard, requiring use of a "liner," applies only to new waste depositories and to new portions of existing waste depositories. 48 Fed. Reg. at 45,941. The secondary standard, applicable to all impoundments, essentially adopts the standards EPA issued under the Solid Waste Disposal Act (SWDA) for hazardous wastes. *Id.* at 45,940. It requires monitoring and levels of concentration low enough to meet drinking water standards within 500 meters of the edges of the waste impoundments. *Id.* at 45,940-41.

The American Mining Congress argues that these ground water standards are unlawful because they apply within the boundaries of the mill sites, and because they impose management, design, and engineering requirements. These arguments do not impress us. We have dealt with the on-site question in the context of radium cleanup and radon emission standards in Part IV of the *Inactive Sites Case*, —— F.2d at ——. We see nothing that compels a different conclusion in the EPA's adoption

of ground water standards for active mill sites. The optimal method of preventing pollution of off-site water supplies is to prevent radiological and other hazardous substances from entering the ground water. General application standards that allow the Nuclear Regulatory Commission (NRC) to choose the means of implementation are consistent with the authority Congress vested in the EPA. Although the regulations require a "liner" for new piles and extensions thereof, we understand that term to refer to any impermeable barrier the NRC may approve that will prevent seepage. *See, e.g.*, II FEIS-AC at A.1-28, A.4-7. The regulations require the industry to satisfy SWDA drinking water concentration standards at specified distances from the pile, but they do not dictate the kind of monitoring system that must be used or the method by which purity levels must be achieved. These decisions are left to the implementing agency, the NRC. *See id.*, at A.1-22, A.6-2.

Section 275(b) of UMTRCA states that the EPA's generally applicable standards must provide "protection of human health and environment *consistent with* the standards required under subtitle (C) of the Solid Waste Disposal Act [SWDA], as amended, which are *applicable to such hazards* . . . ." 42 U.S.C. § 2022(b)(2) (emphasis added). The industry petitioners' principal argument against the EPA's ground water regulations is that the standards adopted were regulations for high-toxicity low-volume chemical wastes and the EPA should have analogized to low-toxicity high-volume mining wastes. Thus, the argument is based upon the contention that the EPA did not adopt standards for *similar* hazards. Further, the industry petitioners assert that the mill tailings rest over aquifers unsuitable for use as drinking water and that it is improper for the EPA to establish drinking water standards.

The EPA made findings that conditions at tailing impoundments are not sufficiently different from the condi-

tions it considered in developing SWDA standards to necessitate a change in approach. 48 Fed. Reg. at 45,941; II FEIS-AC at A.1-2 to -3. In its SWDA regulations the EPA refused to draw a distinction between high-volume low-toxicity mining wastes and low-volume high-toxicity chemical wastes. *See* 45 Fed. Reg. 33,140, 33,173-75 (1980) (dicussion of basis for decision). Apparently Congress has barred the EPA from applying SWDA regulations to certain mining wastes pending an agency study that was incomplete at the time the EPA was required to promulgate final regulations for the active mine sites. *See* II FEIS-AC at A.1-2 to -3. Yet, the EPA was under pressure from Congress to promulgate license site standards by the October 1 deadline. Congress required the EPA to adopt general standards applicable to all sites. The EPA did adopt such standards. In this circumstance, the EPA acted permissibly in adopting standards equivalent to the drinking water standards.

United Nuclear argues that the EPA's ground water standards impermissibly intrude on state control of ground water, a contention that we summarily reject. If United Nuclear has standing to raise the question of preemption, *cf. Mountain States Legal Foundation v. Costle*, 630 F.2d 754, 767 (10th Cir. 1980) (denying standing to pro-industry private organization seeking to challenge EPA air quality regulations), *cert. denied*, 450 U.S. 1050 (1981), we are satisfied that the UMTRCA's directive provides the basis for preemption.

The environmental petitioners argue that the ground water regulations are inadequate. They first claim the EPA's decision not to apply the primary standard to existing tailings impoundments is unreasonable because seepage from these sources is already fouling the environment. The EPA's response is that the existing impoundments are only exempted from the primary standard requiring an impermeable barrier. The impoundments are still subject to the secondary standard. 40 C.F.R. § 192.32

(a)(2). Violation of the secondary standard may require the operator to cease making new deposits and take corrective action. *Id.* § 192.33; *see* 48 Fed. Reg. at 45,941 (discussion of § 192.33). The EPA says it only adopts standards, leaving the methods to achieve the standards to those charged with management of the piles. It also argues that mandatory stoppage of adding to existing piles or removal of existing piles to new, lined impoundments could increase radon emissions and render additional large amounts of land permanently contaminated and unproductive by increasing the number of piles. *See* 48 Fed. Reg. at 19,594-95; II FEIS-AC at A.4-10. We accept as rational the EPA's reasoning on these points.

The environmental petitioners also contend that the EPA should require cleanup beyond the site boundaries. The EPA argues in response that the issue is not properly before us because it was not raised during the comment period and because the challenge is in reality one to the SWDA regulations themselves. In addition, the EPA explains that it determined that existing offsite contamination should be addressed through its emergency powers under SWDA and the "Superfund" statute, the Comprehensive Environmental Response Compensation and Liability Act, 42 U.S.C. §§ 9604, 9606. It notes 1984 congressional amendments to SWDA that require some changes in its approach under that act, and admits it must reevaluate its position under the UMTRCA in light of that development which occurred after it issued the active site final regulations. *See* Brief of Respondents at 93 n.83. We accept as rational this explanation for not imposing requirements for outside-the-boundaries cleanup, and we cannot say the EPA's actions were arbitrary or capricious.

The environmental petitioners assert that the EPA did not properly respond to comments during rulemaking, particularly those concerning "compliance point" monitoring, which suggested that seepage should be monitored in

the vadose zone of rocks or sediment to detect pollution before it reaches the aquifers. We are satisfied that the EPA undertook a determined effort to respond to comments during the rulemaking comment period. *See generally* II FEIS-AC at A.1-1 to 7-5 (summarized comments and responses). The record shows that the EPA did respond to comments on ground water compliance point monitoring generally, and possible vadose zone monitoring in particular. *Id.* at A.4-36 to -37 (compliance point monitoring), A.6-2 to -3 (vadose zone monitoring). The response to comments on vadose zone monitoring was somewhat limited—but apparently because implementation of ground water monitoring has been left to the Nuclear Regulatory Commission. *See id.* at A.1-22, A.6-2. We cannot say that the ground water monitoring *guidelines* laid down by the EPA are irrational or unsuited to the task. *See* 48 Fed. Reg. at 45,942 (guidelines listed).

Petitioners Kepford and Johnsrud argue that the EPA did not give adequate consideration to deep well disposal of mill tailings. The record shows that the EPA did consider this proposal. *See, e.g.*, 48 Fed. Reg. at 19,590; *id.* at 45,931-32; I FEIS-AC at 8-16. The EPA acted within its powers in rejecting this method, rationally finding it had potential for more serious ground water contamination.

In sum, we reject all challenges to the EPA's ground water regulations for the active mill sites.

V

AMAX, Inc., one of the world's leading producers of molybdenum, has petitioned for review of the active site regulations for the specific purpose of challenging the EPA's designation of molybdenum as a "hazardous constitutent" of uranium and thorium mill tailings and subjecting molybdenum to the ground water protection standards. No other petitioner has focused any attack on the identification of particular minerals as nonradio-

logical hazards. Therefore, before considering the merits of AMAX's claims we must consider AMAX's standing to raise the issues in its petition. The EPA asserts that AMAX lacks standing to challenge any aspect of the UMTRCA active site regulations because it does not own or operate any licensed uranium mill tailings sites and therefore is not affected by the regulations. The regulations specifically state that molybdenum is listed as a hazardous constitutent "only for purposes of controlling uranium and thorium byproduct materials. EPA does not intend in this rulemaking to add molybdenum . . . to the SWDA list of hazardous constituents." 48 Fed. Reg. 45,926, 45,944 (1983).

Two sections of the United States Code apply directly to this case. The UMTRCA itself provides that

> "[j]udicial review of any rule promulgated under this section may be obtained by *any interested person* only upon such person filing a petition for review within sixty days after such promulgation in the United States court of appeals for the Federal judicial circuit in which such person resides or has his principal place of business. . . . The court shall have jurisdiction to review the rule in accordance with chapter 7 of Title 5 and to grant appropriate relief as provided in such chapter."

42 U.S.C. § 2022(c)(2) (emphasis added). Section 10(a) of the Administrative Procedure Act, 5 U.S.C. § 702, states that

> "[a] person suffering legal wrong because of agency action, or adversely affected or aggrieved by agency action within the meaning of a relevant statute, is entitled to judicial review thereof."

The concept of standing combines both constitutional and prudential considerations. *See Allen v. Wright*, 52 U.S.L.W. 5110, 5114 (U.S. July 3, 1984); *Valley Forge Christian College v. Americans United for Separation of*

Church and State, Inc., 454 U.S. 464, 471 (1982); *Ozonoff v. Berzak*, 744 F.2d 224, 227 (1st Cir. 1984). At a minimum, Article III of the constitution requires

> "the party who invokes the court's authority to 'show [1] that he personally has suffered some actual or threatened injury as a result of the putatively illegal conduct of the defendant,' . . . and [2] that the injury 'fairly can be traced to the challenged action' and [3] 'is likely to be redressed by a favorable decision.'"

Valley Forge Christian College, 454 U.S. at 472 (citations omitted).

As a preliminary matter, we note that the reviewing court, when ruling on a motion to dismiss for lack of standing, "must accept as true all material allegations of the complaint, and must construe the complaint in favor of the complaining party." *Warth v. Seldin*, 422 U.S. 490, 501 (1975). Even reading AMAX's petition and affidavit generously, we hold that it fails to meet either the constitutional or prudential requirements of the standing doctrine.

First, the injury that AMAX claims it would suffer as a result of the EPA's listing of molybdenum as a toxic substance is indirect. Neither AMAX nor its customers own any uranium mill tailings sites. Therefore, they are not subject to the UMTRCA or its regulations. AMAX, however, alleges that state and local agencies that regulate AMAX's customers are likely to restrict or prohibit the discharge of molybdenum if the EPA classifies molybdenum as a hazardous substance. *See* Affidavit of Dr. Gary G. Van Riper (Deputy Director of Environmental Control, Climax Molybdenum Company, division of AMAX). If this should occur, AMAX would be unable to sell its product and would suffer economic injury. Although an indirect injury can be sufficient to confer standing on a party, the Supreme Court has stated:

> "When a governmental prohibition or restriction imposed on one party causes specific harm to a third party, harm that a constitutional provision or statute was intended to prevent, the indirectness of the injury does not necessarily deprive the person harmed of standing to vindicate his rights. . . . But it may make it substantially more difficult to meet the minimum requirements of Art. III: to establish that, in fact, the asserted injury was the consequence of the defendant's actions, or that prospective relief will remove the harm."

Warth v. Seldin, 422 U.S. at 504-05 (citation omitted).

Although the challenged regulation was adopted over two years ago, AMAX does not refer to a single agency that has restricted or proposed to restrict discharge of molybdenum as a result of this action. AMAX refers only to a *proposed* state regulation in Texas in 1979 classifying molybdenum as a toxic substance that was used as the basis for similar regulations in New Orleans, El Paso, and Dallas. Affidavit of Dr. Gary G. Van Riper at 2-3. Absent any allegation that a single state or local agency has considered adopting the EPA's classification of molybdenum as a hazardous substance, we believe that AMAX has failed to demonstrate that it has or will suffer "concrete and certain harm" as a result of the EPA's action. *National Collegiate Athletic Ass'n v. Califano*, 622 F.2d 1382, 1386 (10th Cir. 1980); *see also United States v. SCRAP*, 412 U.S. 669, 688-89 (1973) ("A plaintiff must allege that he has been or will in fact be perceptibly harmed by the challenged agency action, not that he can imagine circumstances in which he could be affected by the agency's action.").

In reaching this conclusion, we are also influenced by the decision of the United States Court of Appeals for the District of Columbia Circuit in *Association of Investment Brokers v. SEC*, 676 F.2d 857 (D.C. Cir. 1982). In that case, the petitioners challenged the Securities and Ex-

change Commission's (SEC) adoption of revisions to Form U-4, the Uniform Application for Securities Industry Registration. *Id.* at 858-59. The SEC only required broker-dealers that it directly regulated to use the form. *Id.* at 859. However, forty-six states and several self-regulatory organizations, including the National Association of Securities Dealers, Inc. and the New York Stock Exchange, also adopted Form U-4. *Id.* The petitioners were not subject to the SEC's regulation; instead, they alleged that they were indirectly injured by the SEC when other regulatory organizations and states adopted the SEC revisions. In rejecting standing, the court stated that "[a]n order to the Commission concerning the form could require cancellation or modification of provisions for SECO broker-dealer filings but could not direct the self-regulatory organizations and the states to follow suit." *Id.* at 862. The situation before us is comparable; if state and local agencies follow the EPA and classify molybdenum as a toxic substance, AMAX's complaint should be raised before these entities. Indeed, it is possible that the EPA's classification of molybdenum will cause state and local entities to initiate their own investigations of the toxicity of molybdenum. If so, it would be the rules adopted as the result of such investigations that might injure AMAX, not the EPA's actions under an act that does not regulate AMAX's business.

Even if we were to find that AMAX has met the constitutional requirements for standing, we would have to deny it standing based on prudential factors. The Supreme Court recently described the prudential aspects of a court's determination of standing:

> "Standing doctrine embraces several judicially self-imposed limits on the exercise of federal jurisdiction, such as the general prohibition on a litigant's raising another person's legal rights, the rule barring adjudication of generalized grievances more appropriately addressed in the representative branches, and the

> rquirement that a plaintiff's complaint fall within the zone of interests protected by the law invoked."

Allen v. Wright, 52 U.S.L.W. 5110, 5114 (U.S. July 3, 1984).

Although several courts have questioned the continued viability of the zone of interests aspect of the standing doctrine, the Supreme Court has continued to apply it. *Id.* at 5114. This circuit has been lenient in applying the "zone of interest" test. We have said that "unless the legislative history shows the plaintiff to be clearly *not* within the statute's 'zone of interest,' and it rarely does, a court should demand no more than a sensible relation between some subject of the statute and the plaintiff's interest in the outcome of the litigation." *National Collegiate Athletic Ass'n v. Califano*, 622 F.2d at 1386. The EPA specifically disclaims any treatment of molybdenum as a toxic substance other than for purposes of mill tailings byproducts disposal. *See* 48 Fed. Reg. at 45,949. Even generously interpreting the test, particularly in the face of this disclaimer, it is difficult to read the UMTRCA as a statute that in any way intends to regulate producers such as AMAX who do not own or operate any licensed mill tailings sites.

Although AMAX correctly states that direct regulatory impact is not required for a petitioner to come within the interests test, the cases on which it relies involved a far more direct regulatory impact than AMAX alleges that it might incur. In *Cotovsky-Kaplan Physical Therapy Assoc., Ltd. v. United States*, 507 F.2d 1363 (7th Cir. 1975), for example, the plaintiffs, five professional physical therapy corporations, were permitted to challenge HEW regulations that conditioned Medicare payments to home health agencies on their hiring of nonprofit physical therapy corporations. *Id.* at 1364-65. As a result of those regulations, several home health agencies notified plaintiffs of their intent to terminate their contracts. *Id.* In allowing the private corporations to chal-

lenge the regulations, even though they did not apply directly to them, the court stated that

> "if, pursuant to what it perceives to be its statutory authority, a government agency regulates the contractual relationships between a regulated party and an unregulated party, the latter as well as the former may have interests that are arguably within the regulated zone for purposes of testing standing, . . ."

Id. at 1367. In contrast, neither AMAX, its customers, nor the state and local agencies that might adopt the EPA regulations are regulated under the UMTRCA.

In addition, in each of the cases that AMAX cites, the plaintiff was injured when an agency effectively forbade a third party from entering into or continuing a beneficial relationship with the plaintiff. *See Cotovsky-Kaplan Physical Therapy Assoc., Ltd. v. United States, supra*; *Apter v. Richardson*, 510 F.2d 351 (7th Cir. 1975) (subject on behalf of whom application for government grant was submitted entitled to challenge denial of grant).[4] In the instant case, however, the EPA has exercised no authority over either AMAX or its customers.

Accordingly, based on both constitutional and prudential factors, we deny AMAX standing and do not consider its arguments on the merits.

VI

The challenges of all petitioners are rejected; we affirm the validity of the active mill site regulations.

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[4] AMAX also cites *New Jersey Chapter Incorporated of the American Physical Therapy Ass'n v. Prudential Life Ins. Co.*, 502 F.2d 500 (D.C. Cir. 1974), *cert. denied*, 420 U.S. 1004 (1975). In this decision, however, the court never decided the standing issue because it determined that, regardless of standing, the defendants would prevail on the merits. *Id.* at 504.

APPENDIX C

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 192

[A-FRL 2211-8a]

Standards for Remedial Actions at Inactive Uranium Processing Sites

AGENCY: U.S. Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: We are issuing final health and environmental standards to govern stabilization, control, and cleanup of residual radioactive materials (primarily mill tailings) at inactive uranium processing sites. These standards were developed pursuant to Section 275 of the Atomic Energy Act (42 U.S.C. 2022), as added by Section 206 of the Uranium Mill Tailings Radiation Control Act of 1978 (Pub. L. 95-604), and were proposed in April 1980 and January 1981.

The standards apply to tailings at locations that qualify for remedial action under Title I of Pub. L. 95-604. The standards for control provide that the tailings be stabilized in a way that gives reasonable assurance that the health hazards associated with the tailings will be controlled and limited for a long period of time. They also establish a requirement to control releases of radon from tailings piles. The standards for cleanup set limits on the radon decay-product concentration and gamma radiation levels in buildings affected by tailings and on the radium-226 concentration in contaminated land

In response to comments on the proposed standards for disposal and for cleanup, we have evaluated a number of alternatives in terms of their costs and the reductions achievable in potential health effects. A number of changes have been made, including raising some of the numerical limits and eliminating some requirements. The

purpose of most of these changes is to make implementation easier and less costly. The changes should not result in any substantial loss of health or environmental protection over that which would have been provided by the proposed standards.

EFFECTIVE DATE: The final standards take effect on March 7, 1983.

ADDRESSES: *Final Environmental Impact Statement.* Background information is given in the *Final Environmental Impact Statement for Remedial Action Standards for Inactive Uranium Processing Sites.* (FEIS), EPA Report 520/4-82-013-1. Single copies of the FEIS, as available, may be obtained from the Program Management Office (ANR-458), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number 703-557-9351.

Docket. Docket Number A-79-25 contains the rulemaking record. The docket is available for public inspection between 8:00 a.m. and 4:00 p.m., Monday through Friday, at EPA's Central Docket Section (A-130), West Tower Lobby, 401 M Street, S.W., Washington, D.C. 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Dr. Stanley Lichtman, Guides and Criteria Branch (ANR-460), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number 703-557-8927.

SUPPLEMENTARY INFORMATION:

I. Introduction

On November 8, 1978, Congress enacted the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604 (henceforth designated "the Act"). In the Act, Congress stated its finding that uranium mill tailings ". . . may pose a potential and significant radiation health hazard to the public, . . . and . . . that every reasonable effort should be made to provide for stabilization, disposal,

and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings." The Administrator of the Environmental Protection Agency (EPA) was directed to set ". . . standards of general application for the protection of the public health, safety, and the environment . . ." to govern this process of stabilization, disposal, and control.

The Act directs the Department of Energy (DOE) to conduct necessary remedial actions at designated inactive uranium processing sites to achieve compliance with the standards established by EPA. Standards are required for two types of remedial actions: control and cleanup. Control is the operation which places the tailings piles in a condition that will minimize the risk to man for a long time. Cleanup is the operation which reduces the potential health consequences of tailings that have been dispersed from tailings piles by natural forces or removed by man and used elsewhere in buildings or land.

In April 1980, we proposed standards for cleanup of tailings (45 FR 27370, April 22, 1980) and made them effective immediately as interim standards (45 FR 27366, April 22, 1980). We took this action to allow DOE to begin remedial work immediately at some contaminated buildings which posed a high level of risk. In January 1981, we proposed standards for control of tailings piles (46 FR 2556, January 9, 1981) and issued a Draft Environmental Impact Statement (DEIS) covering both the control and cleanup standards. Public hearings on the standards were held in Salt Lake City, Utah, on April 24-25, 1981; in Durango, Colorado, on April 27-28, 1981; and in Washington, D.C., on May 14-15, 1981.

We received a wide range of responses to the proposed standards and the DEIS. Sixty-eight substantive comment letters were received and twenty-three individuals testified or submitted comments at the public hearings. Comments were received from a broad spectrum of par-

ticipants, including private citizens, public interest groups, members of the scientific community, representatives of industry, and State and Federal agencies. We have carefully reviewed and considered these comments in preparing the FEIS and in promulgating these final standards. The written comments are reproduced in the FEIS, which also contains our detailed responses. The major issues raised in public comments, our response to them, and the detailed changes in the standards are given in Sections III and IV. Below we simply summarize the major conclusions reached as a result of our review.

These standards are established to satisfy the purposes of the Act to ". . . stabilize and control . . . tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public." The Act does not provide specific criteria to be used in determining that these purposes have been satisfied. We have therefore made it our objective to establish standards that take account of the tradeoffs between costs and benefits in a way that assures adequate protection of the public health, safety, and the environment; that can be implemented using presently available techniques and measuring instruments; and that are reasonable in terms of overall costs and benefits. We have been especially cognizant of the need to differentiate what would be desirable from what we believe to be necessary to achieve the purposes of the Act.

Substantial dissatisfaction with the proposed standards was expressed in written comments and at the public hearings. In response to these views, we carefully evaluated a number of alternatives with respect to the above factors. Details of each of the alternative control and cleanup standards we considered are given in the FEIS. Selected results of our analysis that are pertinent to our choices for each part of the final standard are given in Section III of this Notice. The following table contains a summary of the alternative standards we considered for control of tailings piles.

ALTERNATIVE STANDARDS FOR CONTROL OF URANIUM MILL TAILINGS PILES

Alternative	Principal requirements		
	Minimum time that controls should prevent erosion and misuse (years)	For radon emission from top of pile (pCi/m^2s)	For water quality protection
No standards	None (radioactivity decays to 10 percent in 265,000 yr).	No limit (The average emission is 500 pCi/m^2s).	None (Toxic chemicals in tailings at concentrations 100 times background).
EPA proposed standard	1,000	2 above background	No increased concentration of toxic chemicals.
Alternative A	1,000 to 10,000	2 above background	No degradation that would prevent present uses.
Alternative B	200 to 1,000	20	Guidance, based on water quality criteria.
Alternative C	Indefinite, long-term	100	Guidance, based on water quality criteria.
Alternative D	Durable cover; 100-yr institutional control; discourage moving of piles.	No requirement	Prevent significant erosion of tailings to surface water or ground water, or treat water before use.
Alternative E	Minimal cover to prevent windblown erosion only; 100- to 200-yr institutional control; move only piles in immediate danger due to floods.	No requirement	No protection required.

The alternative cleanup and control standards can be generally categorized as:

(1) *Least cost* alternatives which provide minimum acceptable health protection, and depend upon the use of institutional methods of control;

(2) *Optimized cost-benefit* alternatives which provide longer term health protection, without reliance on institutional controls, but at somewhat higher costs; and

(3) *Nondegradation* alternatives which attempt to achieve close to the same environmental consequences as might occur if the ore had not been mined; these entail much higher costs, and could result in some undesirable environmental consequences.

Our analysis was based on assuming that remedial actions to satisfy "least cost" tailings pile control standards would entail applying a thin earthen cover and little or no reinforcement of relatively steep side slopes. Integrity of the cover would be assured through active maintenance for 100 years. Only minimal flood protection measures would be applied, and as few as one pile would be moved to a more stable location. Covers would be progressively thicker and less dependent upon care under the more stringent alternatives, with more gradual slopes and greater use of rock for reinforcement. Under the "nondegradation" alternatives, up to half of the piles would be moved to satisfy either water protection or longevity requirements.

The alternative cleanup standards would require progressively more complete removal of tailings from more buildings. Remedial methods that do not involve tailings removal may be used on a limited basis under all but "nondegradation" alternatives.

The more stringent land cleanup alternatives require more complete removal of contaminated material, implying that larger areas may be cleaned up at each contam-

inated location and somewhat greater numbers of sites qualify for cleanup.

We concluded that the standards we originally proposed approach a "nondegradation" alternative that would, in at least some cases, be difficult to implement, since they specify cleanup and control limits close to background levels. More importantly, the small incremental health benefits, when compared to the benefits for less stringent alternatives, do not appear to justify the large additional costs.

We selected an "optimized cost-benefit" rather than a "least cost" alternative for the final standards, in part because it provides much greater protection of health at only a small increase above the least cost alternatives, and in part because it does not place primary reliance on institutional methods of control. The final standards provide for:

(1) *Control systems for tailings piles*—Control and stabilization which will ensure, to the extent reasonably achievable, an effective life of 1000 years, and in any case, for at least 200 years. This control and stabilization will be designed to provide a barrier which will effectively minimize the potential for misuse and spread of the tailings, limit the average radon emission from the surface of tailings piles to no more than 20 pCi/m^2s,[1] protect against flooding, and protect from wind and water erosion. We have also provided an alternative equivalent to the radon emission limit that is stated in terms of the maximum radon concentration in air at locations off the pile.

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[1] A curie is the amount of radioactive material that produces 37 billion nuclear transformations (e.g., decays of radium into radon) per second. A picocurie (pCi) is a trillionth of a curie. One picocurie of material produces just over two transformations per minute. pCi/m^2s is a unit for the release rate of radioactivity from a surface (m=meter, s=second). pCi/g is a unit for the radioactivity concentration in a mass of material (g = gram).

(2) *Flood control*—Diking or other flood protection controls given first consideration, rather than moving piles, when there is a risk from floods.

(3) *Control of waterborne pollutants*—DOE should assess each site and establish any corrective or preventive programs found necessary to meet relevant State and Federal Water Quality Standards and to be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act, as amended.

(4) *Cleanup of buildings*—An objective for reduction of radon decay products of 0.02 WL,[2] with a maximum limit of 0.03 WL.

(5) *Cleanup of dispersed tailings*—Limitations of soil radium content to 5 pCi/g (above background) averaged over the top 15 centimeters of soil, and to 15 pCi/g averaged over any 15 centimeters of soil below this.

(6) *Cleanup of off-site land*—Remedial actions applied only to situations that constitute a hazard; in those cases, cleanup equivalent to the above standard for dispersed tailings.

The Table below provides a summary comparison of the proposed and final standards. The following sections provide a more detailed discussion of the basis for the final standards.

It should be noted that these standards in no way are intended to establish precedents for other situations or regulations involving similar environmental objectives, but with different economic and/or technological circumstances. For example, our forthcoming proposed standards for active uranium mills will be based on an independent analysis of operating and future mills, which

[2] A "working level" (WL) is any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts. Working level is a measure of the concentration of radioactivity in the air, not of how much radiation a person actually receives.

SUMMARY COMPARISON OF PROPOSED AND FINAL STANDARDS

	Proposed	Final
Control of Tailings Piles:		
1. Longevity	At least 1000 years	Up to 1000 years, to the extent reasonably achievable, but at least 200 years.
2. Radon emissions from disposal site.	2 pCi/m²s; equivalent to about 99.6% reduction.	20 pCi/m²s, *or* 0.5 pCi/l in air outside the disposal site; equivalent to about 96% reduction.
3. Water protection	Specific limits for a number of toxic and radioactive contaminants in groundwater; nondegradation of surface water.	Use existing State and Federal standards; apply site-specific measures where needed.
Cleanup of Buildings:		
1. Indoor radon decay products	Shall not exceed 0.015 WL	Shall not exceed 0.03 WL; to the extent practicable, achieve 0.02 WL.
2. Indoor gamma radiation	20 microR/hr	Unchanged.
Cleanup of Land:		
1. Surface	5 pCi/g in any 5 cm layer within one foot of surface.	5 pCi/g in the 15 cm surface layer.
2. Buried	5 pCi/g in any 15 cm layer below one foot.	15 pCi/g in any 15 cm layer below the surface layer.
Exceptions:		
1. Procedure	Site-specific exception procedures . . .	Supplemental standards (may be applied on generic or site-specific basis).
2. Applicability	Where health and safety would be endangered, or where costs clearly outweigh benefits.	Same as proposed; criteria also provided to avoid cleanup of small amounts of tailings and inaccesiible tailings posing minimal hazards.

may result in different standards. Similarly, our remedial action standard for contaminated buildings should not be taken as an appropriate design goal for indoor radon decay product concentration in new housing, or as a remedial action goal appropriate for all circumstances.

II. Summary of Background Information

Beginning in the 1940's, the U.S. Government purchased uranium for defense purposes. As a result, large quantities of tailings were created by the uranium milling industry. These tailings are a sand-like material, and are attractive for use in construction and soil conditioning. Most of these mills are now inactive, and the ultimate disposal of their tailings has not yet taken place. In addition, tailings have been dispersed from the piles at most of the sites by natural forces, or have been removed by man for use in or around buildings, or on land. The Act provides for the cleanup of these offsite tailings as well as for the long-term control of the tailings piles.

Congress designated twenty-two inactive sites, and the Department of Energy has added two more. The sites are located in the West, predominantly in arid areas, except for a single site at Canonsburg, Pa. Tailings piles at these sites range in area from 5 to 150 acres and in height from a few feet to as much as 230 feet. The amount of tailings at each site ranges from only residual contamination to 2.7 million tons. The twenty-four designated sites combined contain about 26 million tons of tailings covering a total of about 1,000 acres.

The most important hazardous constituent of uranium mill tailings is radium, which is radioactive. We estimate that these tailings contain a total of about 15,000 curies of radium. Radium, in addition to being hazardous itself, produces radon, a radioactive gas whose

decay products can cause lung cancer. The amount of radium in tailings, and, therefore, the rate at which radon is produced, will decay to about 10% of the current amount in several hundred thousand years. Other potentially hazardous constituents of tailings include arsenic, molybdenum, selenium, uranium, and, usually in lesser amounts, a variety of other toxic substances. The concentrations of these materials vary from pile to pile.

Radiation and toxic materials may cause a variety of cancers, and other diseases, as well as genetic damage and teratogenic effects. Tailings are hazardous to man because: (1) decay products of radon may be inhaled and increase the risk of lung cancer; (2) individuals may be exposed to gamma radiation from the radioactivity in tailings; and (3) radioactive and toxic materials from tailings may be ingested with food or water. We believe the first of these hazards is clearly the most important.

The radiation hazard from tailings lasts for many hundreds of thousands of years, and some nonradioactive toxic chemicals persist indefinitely. The hazard from uranium tailings therefore must be viewed in two ways. In themselves, the tailings pose a present hazard to human health. Beyond this immediate, but generally limited, health threat, the tailings are vulnerable to human misuse and to dispersal by natural forces for an essentially indefinite period. In the long run, this threat of expanded, indefinite contamination overshadows the present dangers to public health. The Congressional report accompanying the Act expressed the view that the methods used for remedial actions should not be effective for only a short period of time. It stated: "The committee believes that uranium mill tailings should be treated . . . in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms," and, that "The Committee does not want to visit this problem again with additional aid. The remedial action must be done right

the first time." (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., Pt. I, p. 17, and Pt. II, p. 40 (1978).)

For the purpose of establishing standards for the protection of health, we assume a linear, nonthreshold dose-effect relationship as a reasonable basis for estimating risks to the general public from radiation. This means we assume that any radiation dose poses some risk and that the risk of low doses is directly proportional to the risk that has been demonstrated at higher doses. We recognize that the data available preclude neither a threshold for some types of damage below which there are no harmful effects, nor the possibility that low doses of gamma radiation may be less harmful to people than the linear model implies. However, the major radiation hazard from tailings arises from alpha radiation, and the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (the BEIR Committee) stated in their 1980 report that for ". . . radiation, such as from internally deposited alpha-emitting radionuclides, the application of the linear hypothesis is less likely to lead to overestimates of risk, and may, in fact, lead to underestimates."

Our quantitative estimates of radiation risk are based on our review of epidemiological studies, conducted in the United States and in other countries, of underground miners of uranium and other metals who have been exposed to radon decay products, and on three reports: *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (1972) and *Health Effects of Alpha Emitting Particles in the Respiratory Tract* (1976) by the BEIR Committee, and the report of the United Nations Scientific Committee on the Effects of Atomic Radiation entitled *Sources and Effects of Ionizing Radiation* (1977). Details of our risk estimates are provided in *Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Lands* (EPA 520/4-78-013) and in the FEIS.

Although the studies of underground miners show that there is a significant risk of lung cancer from exposure to radon decay products, there is some uncertainty about its magnitude. Exposures of miners are estimated from the time spent in each location in a mine and the measured radon decay product levels at those locations. However, radon decay product measurements were infrequent and often nonexistent for exposures of miners prior to the 1960's. The uncertainty increases when data for miners are used to estimate risk to the general population because there are differences in age, physiology, exposure conditions, and other factors between the two populations. Nevertheless, we believe the information available provides an estimate of risk which is probably reliable within a factor of two or three, and that this constitutes an adequate basis for these standards.

It is not possible to reduce the risk to zero for people exposed to radiation or, for that matter, to many other hazardous materials. In order to decide on an appropriate level of a small residual risk, we evaluated the costs and benefits of different levels of control. We also considered technical difficulties associated with implementing different levels of control.

The legislative record shows that Congress intended that EPA set general standards and not specify any particular method of control. Therefore, our analyses of control methods, costs, risks, and other pertinent factors emphasize the general characteristics of uranium mill tailings and the designated sites. The Act gives other agencies of the Federal Government the responsibility to decide how to satisfy these standards at specific sites. They will issue site-specific Environmental Impact Statements or Environmental Assessments, as appropriate, covering such matters.

The information upon which we based these health and environmental standards for control and cleanup of tail-

ings from inactive uranium processing sites is summarized below. Additional background information and more complete presentations are given in our notices of proposed rulemaking (45 FR 27370, April 22, 1980, and 46 FR 2556, January 9, 1981) and in the FEIS.

A. The Risks from Tailings

Uranium mill tailings can affect man through four principal environmental pathways:

• *Diffusion of radon-222, the decay product of radium-226, from tailings into indoor air.* Breathing radon-222, an inert gas, and its short half-life decay products, which attach to tiny dust particles, exposes the lungs to alpha radiation (principally from polonium-218 and polonium-214). The exposures involved may be large for persons who have tailings in or around their houses, or who live very close to tailings piles. Additional, but smaller, exposures to alpha radiation may result from long-lived radon-222 decay products (principally lead-210 and polonium-210). Exposure due to radon from tailings in or around buildings is best estimated from direct measurements of its decay products in indoor air.

• *Direct exposure to gamma radiation.* Many of the radioactive decay products in tailings produce gamma radiation. The most important are lead-214, bismuth-214, and thallium-210. Hazards from gamma radiation are limited to persons in the immediate vicinity of piles or removed tailings. Exposure due to gamma radiation from tailings is readily estimated from direct measurements.

• *Dispersal of small particles of tailings material in the air.* Wind erosion of unstabilized tailings piles creates airborne tailings material. The predominant dose is to the bones from eating foods contaminated by thorium-230, radium-226, and lead-210, and is small. Exposure due to airborne transport of radon and particulates

from a pile usually cannot be directly measured, but may be estimated using meteorological transport models.

• *Waterborne transport of radioactive and toxic material.* Dispersal of unstabilized tailings by wind or water, or leaching, can carry radioactive and other toxic materials to surface or ground water. Current levels of contamination appear to be low or nonexistent. However, some long-term future contamination of surface and ground water and consequent intake by man and animals is possible. Potential exposures due to the transport of waterborne contaminants are highly site-specific and can generally only be determined by a careful survey program.

The following discussion of risks focuses largely on current biological effects; however, these current effects could be expanded by future misuse of tailings by man and by uncontrolled effects of natural forces. Our standards reflect consideration of both current and future impacts of tailings.

1. Air Pathways. We estimated the hazards posed by radon emissions to air from uranium mill tailings piles and from tailings used in and around houses. For the first case we used meterological models and considered people in the neighborhood of the pile, the population in the local region, and the remainder of the national population. For the second, we drew largely upon experience from contaminated houses in Grand Junction, Colorado. Four sources of exposure were considered; inhaled short-lived radon decay products, gamma radiation, the long-lived radon decay products, and airborne tailings.

From our analysis we conclude:

(a) Lung cancer caused by the short-lived decay products of radon is the dominant radiation hazard from tailings. Effects of gamma radiation, of long-lived radon decay products, and of airborne tailings from the piles

are generally much less significant, although high gamma radiation doses may sometimes occur.

(b) Individuals who have tailings in or around their houses often have large exposures to indoor radon and hence high risks of lung cancer. For example, in 50% of a sample of 190 houses with tailings in Grand Junction, Colorado, we estimate that the lifetime excess risk due to exposure to short-lived radon decay products prior to remediation may have been greater than 4 chances in 100.

(c) Individuals living near an uncontrolled tailings pile are also subjected to high risks from short-lived radon decay products. For example, we estimate that people living continuously next to some of the piles may have lifetime excess lung cancer risks as high as 4 chances in 100.

(d) Based on models for the cumulative risk to all exposed populations, we estimate that, without remedial action, the radon from all the inactive sites considered together could cause about 170 to 240 potential excess lung cancer deaths per century. Of these, 55% to 80% are projected to occur among persons living less than 50 miles from a pile.

There is a substantial uncertainty in these estimates because of uncertainties in the rate of release of radon from tailings piles, the exposure people will receive from its decay products, and from our incomplete knowledge of the effects on people of these exposures. In addition, our estimates are based upon current sizes and geographical distributions of populations. If populations increase in the future, the estimated impact would be larger.

We concluded that a primary objective of standards for *cleanup* of tailings should be to remove or reduce existing and potential risks due to radon decay products indoors. Such risks from indoor radon decay products arise in two ways—in existing buildings where tailings were

used in construction and cause elevated levels, and from land contaminated sufficiently to cause elevated levels in new construction. A secondary objective should be to reduce high exposures to gamma radiation due to tailings in buildings or on land away from the tailings piles.

We concluded that a primary objective of standards for *control* of tailings should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces, such as wind, rain, and flood waters. A second objective should be to reduce radon emissions from tailings piles. A third objective should be the elimination of significant exposure to gamma radiation from tailings piles.

2. Water Pathways. Although water contamination does not now appear to be a significant source of immediate radiation exposure at the piles, both radionuclides and nonradioactive toxic substances, such as arsenic, molybdenum, and selenium, could be leached or otherwise removed from tailings and contaminate water resources. If this occurred, it could then affect crops, animals, and people. Such contamination could, in principle, be caused by either past or future releases from the tailings. Tailings piles at inactive sites have already lost most of the water deposited in them during mill operations through evaporation and seepage. However, elevated concentrations of radioactive or toxic substances in ground water have been observed at only a few of the designated sites (four are identified in the FEIS), and in some standing water ponds (but not in running water). Any future water contamination would arise from the effects of rain or through flooding of a pile, from penetration of a pile from below by ground water, or from leaching of tailings transported off a pile.

A theoretical analysis performed for the Nuclear Regulatory Commission (NRC) of a larger model pile showed that contamination of ground water by selenium,

sulfate, manganese, and iron might exceed current drinking water standards over an area 2 kilometers wide and 8 to 30 kilometers long. However, more than 95% of this projected contamination was attributable to initial seepage of process water discharged to the pile during mill operations. The movement of contaminants through a pile and subsoil to ground water depends on a combination of complex chemical and physical properties, as well as on local precipitation and evaporation rates. Chemical and physical processes can effectively remove or retard the flow of many toxic substances passing through subsoil. However, some contaminants such as arsenic, molybdenum, and selenium, can occur in forms that are not removed. Typically, ground water can move as slowly as a few feet per year, and only in coarse or cracked materials does the speed exceed one mile per year. For these reasons, contaminants from tailings may not affect the quality of nearby water supply wells for decades or longer after they are released. However, once contaminated, the quality of water supplies cannot usually be easily restored simply by eliminating the source (although, in some cases removing or isolating the tailings may contribute to improving water quality).

Based on results from the NRC generic model for mill tailings piles, it is likely that the few observed cases of ground water contamination resulted from seepage of the original liquid waste discharges from the mill. Additional future contamination of ground water should be much smaller, and in most cases would be expected to be minimized by measures required to control misuse of tailings by man and dispersal by wind, rain, and flood waters. These measures should also effectively eliminate the threat of contamination of surface water by runoff or from leaching of tailings transported off piles, and provide reasonable protection of surface and ground water from contamination by flooding. However, at a few specific sites, especially in areas of high rainfall or

where ground water tables intersect the piles, special consideration of possible future contamination of ground water may be needed.

Though a few sites appear to have some existing contamination due to the presence of tailings, we believe it will usually not be feasible or practical to remove the contaminants from subsoil or ground water. Whether or not it is feasible or practical to restore an aquifer and to what degree will depend on site-specific factors, such as the ability to restore the aquifer in its hydrogeologic setting, the cost, the present and future value of the aquifer as a water resource, the availability of alternative supplies, and the degree to which human exposure is likely to occur.

We concluded that potential contamination of surface and ground water at the inactive sites must be considered on a site-specific basis. The remedial program should provide for adequate hydrological and geochemical surveys of each site as a basis for determining whether specific water protection or cleanup measures should be applied. In many cases, the control measures needed for other purposes should reduce any potential for contamination.

In addition to the available information upon which we based our conclusion, hydrological and geochemical studies are presently being conducted or planned at a number of sites. The purpose of these studies is to gather additional information so as to more fully assess any actual or potential ground water contamination and to better understand the mechanism of contaminant movement. The studies will identify the extent and character of contaminants remaining in the piles, as well as the direction, rate of movement and degree of attenuation of any contaminants already released. In particular, attention is being given to identifying the likelihood of contaminants reaching an actual or potential water supply source. We are currently reviewing current studies and

will review future studies assessing the site-specific factors related to potential ground water contamination.

As stated previously in this Section II, site-specific Environmental Assessments (EAs) or Environmental Impact Analyses (EIAs) will be prepared for each site. We will review the information generated as part of those. The EAs or EIAs would gather data on a site-specific basis which would either characterize the site completely or confirm the use of general models in determining potential mechanisms for impact or lack of impact on ground water.

We believe that it is important to conclude these studies as quickly as possible. These studies will provide a more complete data and analytical base to allow us to reevaluate the decision not to set ground water protection standards. Information to be obtained as a part of the studies will include the response of the tailings and interstitial fluids to water table and precipitation stimuli; distribution of radionuclides and other contaminants within the tailings pile; identification of mobile constituents within the tailings and ground water system; and analyses of the mechanisms for the release and transport of the contaminants both to the surface and downward to ground water.

To date, the results of more recent studies than those we described in our FEIS strongly support our decision not to issue general numerical water protection standards. We intend to continue to review additional information as it becomes available, and will reconsider our decision if the need to do so becomes apparent.

B. Cleanup and Control of Tailings

1. Control of Tailings Piles. The objectives of tailings control and stabilization efforts are to prevent their misuse by man, to reduce radon emissions (and gamma radiation exposure), and to avoid the contamination of land

and water by preventing erosion by natural processes. The longevity (i.e., long-term integrity) of control is particularly important. This is affected by the potential for disruption by man; by the probability of occurrence of such natural phenomena as earthquakes, floods, windstorms, and glaciers; and by chemical and mechanical processes in the piles. Prediction of the long-term integrity of control methods becomes less certain as the period of concern increases. Beyond several thousand years, long-term geological processes and climatic change become the dominant factors.

Methods to prevent misuse by man and disruption by natural phenomena may be divided into those whose integrity depends upon man and his institutions ("active" controls) and those that do not ("passive" controls). Examples of active controls are fences, warning signs, restrictions on land use, and inspection and repair of semipermanent tailings covers, temporary dikes, and drainage courses. Examples of passive controls are thick earthen covers, rock covers, massive earth and rock dikes, burial below grade, and moving piles out of locations highly subject to erosion, such as unstable river banks.

Erosion of tailings by wind, rain, and flooding can be inhibited by contouring the pile and its cover, by stabilizing the surface (with rock, for example) to make it resistant to erosion, and by constructing dikes. If necessary, erosion can be inhibited by burying tailings in a shallow pit or moving them away from a particularly flood-prone or otherwise geologically unstable site.

Methods to control release of radon range from applying a simple barrier (such as an earthen cover) to such ambitious treatments as embedding tailings in cement or processing them to remove radium, the precursor of radon. Covering tailings with a permeable (porous) barrier, such as earth, delays radon diffusion so that most of it decays and is effectively retained in the cover. In addition to simple earthen covers, other less permeable

materials such as asphalt, clay, or soil cement, usually in combination with earthen covers, may be used. The more permeable the covering material, the thicker it must be to achieve a given reduction in radon release. However, maintaining the integrity of very thin impermeable covers, such as plastic sheets, even over a period as short as several decades is unlikely given the chemical and physical stresses present at piles.

The most likely constituents of covers for use to control tailings are locally available earthen materials. The effectiveness of an earthen cover as a barrier to radon depends most strongly on its moisture content. Typical clay soils in the uranium milling regions of the west exhibit ambient moisture contents of 9% to 12%. For nonclay soils ambient moisture contents range from 6% to 10%. The following table provides, as an example, the cover thicknesses that would be required to reduce the radon emission to 20 pCi/m^{-2}s for the above ranges of soil moisture. Three examples of tailings are shown that cover the probable extreme values of radon emission from bare tailings at the designated sites (100 to 1000 pCi/m^{-2}s); the most common value is probably somewhat less than 500 pCi/m^{-2}s.

ESTIMATED COVER THICKNESS (METERS) TO ACHIEVE 20 pCi/m^{-2}s

Radon emission from tailings (pCi/m^{-2}s	Percent moisture content of cover			
	6	8	10	12
100	1.7	1.3	1.0	0.7
500	3.4	2.6	2.0	1.5
1,000	4.1	3.2	2.4	1.8

These values are for simple homogeneous covers. In practice, multilayer covers using clay next to the tailings can be used to significantly reduce the total thickness required.

Methods that control radon emissions will also prevent transport of particulates from the tailings pile to air or to surface water.[3] Similarly, permeable covers sufficiently thick for effective radon control will also absorb gamma radiation effectively (although thin impermeable covers will not).

Control of possible contamination of ground water is difficult. In the few cases where this is a potentially significant problem, clay liners and/or clay caps may provide a good degree of protection for at least many decades. However, more permanent protection may require removal to a site with more favorable hydrological, geochemical, or meteorological characteristics.

Very effective long-term inhibition of misuse by man, as well as of releases to air and surface water, could be achieved by burying tailings in deep mined cavities. In this case, however, direct contact with ground water would be difficult to avoid. The potential hazards of tailings could also be reduced by chemically processing them to remove contaminants. Such processes have limited efficiencies, however, so the residual tailings would still require control. Furthermore, the extracted substances (e.g., radium and thorium) would be concentrated, and would require further control.

We analyzed the costs of a number of possible control methods. The total cost is affected most strongly by the type of material used to stabilize the surface against erosion and inhibit misuse by man, by the water protection features required, and by the number of piles that must be moved to new sites. In general, costs of covers using man-made materials (e.g., asphalt) are somewhat higher than costs for earthen covers. Active control measures

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[3] However, recent studies suggest the possibility that some chemical processes in tailings piles could carry dissolved contaminants upward, perhaps even through earthen coverings. Control system designers must carefully consider this possibility.

are usually less costly in the short term than are passive measures. The costs for burial of tailings piles or for using chemical processing to extract radium (and perhaps other substances) are much higher than those for disposal using covers. We find that, given a decision to carry out any significant stabilization, the total cost of control using earthen covers does not depend strongly on the degree of reduction of radon emissions, for reductions by up to about a factor of 50 (the maximum that would probably be required at any site under these standards).

2. Cleanup of Tailings. The objective of cleanup of tailings from buildings is to reduce elevated indoor levels of radon decay products and gamma radiation. The objective of cleanup of tailings from land is to remove the potential for elevated levels of radon decay products in future buildings, and exposure of people to gamma radiation.

A variety of methods for cleanup of buildings are available. The most commonly used, and the most reliable and permanent measure, is to dig out the tailings and return them to the pile. This is sometimes relatively easy, such as removing tailings from outside footings, but may be very difficult, as in removing tailings from under a concrete slab 'floor in a finished room. Other methods include air filtration, improved ventilation, and the use of sealants to keep out radon.

Windblown tailings on lands around a tailings pile are usually removed by scraping off the top few inches of earth with earth-moving equipment and adding it to the pile. Land cleaned up in this way is relatively easily restored to close to background levels of radioactivity because windblown tailings are usually on the surface and easy to remove. Generally the cost is determined by the amount of land scraped, and not by the depth of scraping required. Alternatively, the land could be removed from

productive use, access restricted, and the tailings fixed on the site by deep plowing.

When tailings have been removed from piles and misused in other ways, such as for soil conditioners in gardens and yards or as fill under detached buildings, the usual cleanup measure is to dig up the tailings and return them to the pile.

III. Resolution of Major Issues Raised in Public Comments

A. The Basis for the Standards

1. Health Risk Models. Some commenters considered that the models we used to estimate risks from breathing radon decay products underestimate the risk. More, however, argued that the models overestimate the risk. Some of these comments argued that the use of data on exposure of underground miners was not valid for estimating risks to the general public and suggested that we should use a lower risk estimate recently published as a contributed article in *Nature* (*290*:98, 1981).

We have reviewed the evidence presented and conclude that it does not support changing the risk models we have used. We agree that some evidence exists that risks may be either higher or lower than those we use, but, when all the available information is carefully considered, this evidence is not compelling. It is also true that the use of data on underground miners to predict risks to the general public is less than ideal; however, we have corrected for the most obvious difference (breathing rate) and do not believe this substantial body of evidence can be ignored. Finally, the estimates published in the article in *Nature* are not convincing. The upper limit of lung cancer risk given by these authors is apparently based on assuming that the total period of risk following exposure is only 15 years. However, the evidence from the Japanese A-bomb survivor data, the only large body of data for a

general population, leads to use of a lifetime period of risk following exposure. Our detailed responses to these comments are presented in the FEIS.

2. Cost Estimates. Commenters suggested that our estimates of the costs to implement the standards were low (by a factor of two or more) and that we had not included costs for engineering, field supervision, contingencies, or for reclamation of borrow pits from which cover material was obtained.

Many of these comments are correct. Our estimates in the DEIS were expressed in 1978 dollars. Costs of some construction activities have increased substantially between 1978 and 1982. We have revised our cost estimates to reflect these changes, and have also included previously omitted costs for engineering, field supervision, contingencies, and reclamation of borrow pits. We have analyzed specific estimates of the cost of meeting the proposed standards and find that our revised estimates are lower than those of the DOE, but in substantial agreement with those provided by industry and NRC. Our cost estimates are reported in detail in the FEIS.

3. Cost-Benefit Analysis. Commenters expressed the view that the cost of implementing the proposed standards will be high compared to the benefits, that we failed to carry out a cost-benefit analysis for these standards, or that we did not adequately consider alternatives to the standards proposed.

It is not possible to carry out a formal quantitative cost-benefit analysis for these standards. Many of the hazards reduced (or avoided) through their application (or through application of alternative standards) can neither be evaluated quantitatively nor restated in terms of a common index of value. The major hazard, the extent of possible future misuse of tailings by man, is almost impossible to quantify. A further complication is that the benefits of successful control accrue over a very long period of time, whereas the costs occur now. We can

only roughly estimate how long control will last and how many cases of lung cancer might be avoided over the full term of effective control.

Instead of a quantitative cost-benefit analysis, we have cited examples of the impact of misuse and dispersal by wind and water in the FEIS, and have estimated the impact of radon emissions from unstabilized piles. We have then estimated the extent to which these impacts might be avoided over the long term under realistic alternative standards, and made judgments about which alternatives offer the most cost-effective reduction of these impacts. The final standards are based on the results of such an analysis of alternatives, including a detailed consideration of their costs. This information is presented in Chapters 6 and 7 of the FEIS. Based on these analyses, we have made a number of changes (described in Sections B and C, below) to make the standards more cost-effective and easier to implement.

One notable conclusion from our analysis is that providing tailings piles with thick, durable covers costs surprisingly little more than applying minimal covers that will require maintenance and last a much shorter time. This conclusion follows from the large start-up expenditures related to managing the remedial program and undertaking any significant level of remedial work at mill sites. Thick covers offer greatly increased benefits from inhibiting misuse, controlling radon emissions, and increased longevity of the covers' effectiveness. For example, we estimate that the final control standard provides about ten times greater overall benefits than the lowest cost alternative standard, for only about 25 percent greater cost. Therefore, given that tailings piles will be stabilized under any of the alternatives we considered, we find it cost-effective to stabilize them well. This observation strongly influenced our choice of a radon release standard, as discussed in Section III.B.2, below.

Cost and benefit estimates for the alternative standards we considered are reported in detail in the FEIS; we briefly summarize here only our estimates for the final standards we selected.

Costs: We estimate the remedial action costs for mill sites and for off-site cleanup will be 158 and 38 million (1981) dollars, respectively. DOE has estimated its program development and management ("overhead") costs as 118 million (1981) dollars. These estimated total expenditures of 314 million (1981) dollars will occur over a period of seven years or more.

Benefits: We estimate benefits under the assumption, when appropriate, that tailings pile control systems will be partially effective longer than the standard requires. Control ssytems are required to be effective for as long as reasonably achievable up to 1000 years, but for not less than 200 years. Under this standard most of the 24 tailings pile will be stable against erosion and casual intrusion for misuse for much longer than 1000 years. Those few piles that are susceptible to flood damage will be protected for at least 200 years, and might not suffer real damage for much longer. During the period of full control, the maximum risk for individuals living very near a tailings pile from exposure to its radon emissions will be reduced by about 97%, from about 3 chances in 100 to about 1 chance in 1000. An estimated 200 potential premature deaths per century will be avoided initially, for a total of many thousands over the life of the cover. The potential for or existence of water contamination from tailings piles will be evaluated and any protective or remedial actions that the implementing agencies determine are warranted will be taken. We further estimate that about 60 premature deaths will be avoided by cleaning up contaminated buildings. An undeterminable additional number of deaths and the institutional burden of applying land-use controls may be avoided by cleaning up

1900 acres of land containing windblown tailings and about 3200-6500 additional locations where tailings have been brought for inappropriate uses.

4. Scope of the Standards and the EIS. Commenters expressed the view that some important impacts of mill tailings were not adequately considered in the DEIS and that we had not considered all of the available pertinent data. They cited inadequate consideration of (a) the health impacts of toxic elements, (b) radiation doses to man from the food pathway, and (c) the effects of radionuclides and toxic elements on plants and animals.

We have reviewed the available data on toxic elements in tailings and improved the FEIS in this respect (Appendix C). We have concluded that it is reasonable to expect that hazards from toxic elements will be adequately limited if control and cleanup are carried out according to these final standards. We have also reviewed the radiation doses from ingestion of food and confirmed our earlier conclusion that the risks from this pathway are small. We have not specifically required measures to protect animals and plants from the hazards of radioactivity, since we have concluded that the impacts are small.

Some comments expressed the view that the proposed standards were too narrow in scope to adequately protect public health. For example, it was proposed that the standards should include: Limits for radionuclide concentrations in air particulates and in vegetation; limits for toxic elements in soil; guidance for the interim period prior to remedial actions; and radiation protection criteria for workers who perform remedial actions.

We have considered these comments and believe that no changes are needed. If control and cleanup are carried out according to these final standards, the health impact from radionuclides in air and from food pathways, and from toxic elements in soil, which are already low, would

be further mitigated. Workers are already protected under existing Federal Guidance for occupational radiation exposures. Finally, the impacts that will occur prior to completion of remedial actions are sufficiently small that we do not believe special interim standards are justified.

B. The Standards for Control of Tailings Piles

1. Longevity of the Control. Some commenters expressed the view that the proposed requirement that stabilization and control last for at least 1000 years is unreasonable because events cannot be predicted over this period of time with sufficient certainty. They recommended a period of no more than 100 to 200 years, and that active institutional care, such as access control and periodic maintenance, be permitted. Other commenters recommended that the longevity required should be greater than 1000 years, and expressed the view that a requirement for longevity of up to 10,000 years is practical.

We consider the single most important goal of control to be effective isolation and stabilization of tailings for as long a period of time as is reasonably feasible, because tailings will remain hazardous for hundreds of thousands of years. The longevity of tailings control is governed chiefly by the possibility of intrusion by man and erosion by natural forces. Reasonable assurance of avoiding casual intrusion by man can be provided through the use of relatively thick and/or difficult-to-penetrate covers (such as soil, rock, or soil-cement). No standard can guarantee absolute protection against the purposeful works of man, and these standards do not require such protection. Protection against natural forces requires consideration of wind and surface water erosion, and of the possibility of flood damage. Wind and surface water erosion are relatively well-understood and predictable, and

are easily inhibited through the use of rock or, in some cases, vegetative surface stabilization. Similarly, a body of scientific and engineering knowledge exists to predict the frequency and magnitude of floods for periods of many hundreds of years, and to provide the engineering controls to protect against such floods (including the possibility of moving a pile if this is more economical). We considered longevity requirements ranging from 100 to 10,000 years and have concluded that existing knowledge permits the design of control systems for these tailings that have a good expectation of lasting at least for periods of 1000 years. We recognize that it may not always be practical, however, to project such performance with a high degree of certainty, because of limited engineering experience with such long time periods.

We know no historical examples of societies successfully maintaining active care of decentralized materials through public institutions for periods extending to many hundreds or thousands of years. We have concluded that primary reliance on passive measures is preferable, since their long-term performance can be projected with more assurance than that of measures which rely on institutions and continued expenditures for active maintenance.

Section 104 of the Act requires the Federal Government to acquire and retain control of these tailings disposal sites under licenses issued by the Nuclear Regulatory Commission (NRC). The NRC is authorized to require performance of any maintenance, monitoring, and emergency measures that are needed to protect public health and safety. As long as the Federal Government exercises its ownership rights and other authorities regarding these sites, they should not be systematically exploited by people or severely degraded by natural forces.

We believe that these institutional provisions are essentail to support any project whose objectives is [sic] as long term as are these disposal operations, and for which we

have as little experience. This does not mean that we believe primary reliance should be placed on institutional controls; rather, that institutional oversight is an essential backup to passive control. We note, in this regard, that the remedial actions required by these standards would not make it safe to build habitable structures on the disposal sites. Federal ownership of the sites is assumed to preclude such inappropriate uses.

In the final standards we have modified the requirement for longevity of control so as to assure that it is practical for agencies to certify that the standards are implemented in all cases. We recognize that this is a remedial action program, that these sites were not chosen with long-term disposal in mind, and that our ability to predict the longevity of engineered designs is not always adequate to the task at hand. The proposed standard required a longevity of control of at least 1000 years. The final standard requires that control measures be carried out in a manner that provides reasonable assurance that they will last, to the extent reasonably achievable, up to 1000 years and, in any case, for a minimum of 200 years. The widely varying characteristics of the inactive sites, the uncertainties involved in projecting performance of control measures over long periods of time, and the large costs involved in moving some tailings piles to provide a very high degree of assurance of longevity make this change appropriate. (We estimate up to 50 million dollars might be unnecessarily spent to move piles under the proposed requirement for a longevity of at least 1000 years.) The change does not signify that there are circumstances under which the term of protection contemplated by the proposed standards is not appropriate. The change merely acknowledges that implementing agencies may in some cases have difficulty certifying that control measures that are appropriate can reasonably be expected to endure without degradation for 1000 years. Man's ability to predict the future is notoriously limited. That

fact, which on the one hand warrants our making responsible societal efforts to limit risk to future generations, also warrants our refraining from actions undertaken merely in the name of necessarily artificial levels of statistical certainty.

We selected this period of period of [sic] performance because we believe there is a reasonable expectation that readily achievable controls will remain effective for at least this period. However, we recognize that uncertainties increase significantly beyond a thousand years, and we conclude it would be unreasonable to require that assurance be provided that the controls will be effective for periods of up to 10,000 years.

2. The Radon Release Limit. Some commenters expressed the view that the proposed radon emission standard of 2 pCi/m^{2}s from the surface of a tailings pile was either unreasonably low or unnecessary. Others suggested that proper consideration of costs and benefits would lead to a higher standard, in the range of 40-100 pCi/m^{2}s. Some urged that the standards for radon be expressed as a limit on ambient air concentration at the site boundary, rather than as an emission limit. Others were concerned that the proposed level could not be reliably implemented, since it is close to background levels. Finally, many argued that radon emitted from tailings piles does not constitute a significant health hazard because it cannot be distinguished from background radon levels a short distance from a tailings pile (ie., ¼-½ mile), and that, therefore, there is no need for a radon emission standard.

We believe that limiting radon emissions from tailings piles serves several necessary functions: reducing the risk to nearby individuals and individuals at greater distances; and furthering the goals of reliable long-term deterrence of misuse of tailings by man and control of erosion of piles by natural processes. The degree of reduction of radon emissions achieved by a disposal system is more or less directly related to the degree of abatement of each of these hazards.

Our analysis predicts significant risk to people living next to tailings piles, and field measurements confirm elevated levels of radon in air close to the piles. If radon emissions are not reduced, we estimate that individuals residing permanently near some of the piles could incur as much as three to four chances in a hundred of a fatal lung cancer in addition to normal expectations. The fact that increases in radon levels due to the piles cannot be distinguished relative to background levels further away from a pile does not mean that radon is not present or that there is no increased risk from this radon—it merely means that measurements are not capable of unambiguously detecting such levels. Limiting radon release, therefore, not only benefits the nearby individual, but also reduces the adverse effects of radon well beyond the immediate vicinity of the site.

Radon emission was selected as the preferred quantity to be specified by the standard because, unlike ambient air concentration at the site boundary, it is directly related to the degree of radon control achieved. A site boundary standard would not necessarily require any control of radon emissions (since the boundary might be moved arbitrarily far from the pile), and, in any case, compliance would depend on indefinitely excluding public access across the boundary.

We have concluded that a limit on a radon emission is the most direct and appropriate means for furthering the Congressional objective of adequate and reliable long-term control of tailings. Such a limit assures a sufficient earthen cover (or its equivalent) to provide an acceptable degree of stabilization and isolation of the tailings over a long period of time. Congress did not intend that EPA set standards for one generation only, or that it set standards without consideration of the long-term reliability of whatever means are available for implementing them. (Similarly, Congress anticipated that short-term institutional controls would not provide the primary basis for protection.) Although the implementing agencies will

decide which specific controls to employ, this does not preclude our considering, in accordance with Congress' directive, the effect of a particular choice of a numerical limit on the maintenance of future control. Therefore, in selecting the value for radon emissions, an important consideration was that the standard promote the objectives of adequate isolation and stabilization to control both intrusion by man and erosion by natural forces.

We have reevaluated the costs and benefits of alternative standards and have revised the radon emission standard to 20 pCi/m²s, in part because we concluded that the incremental benefits of the proposed standards are not justified by the increased costs, and in part because recent results of tests of covers indicate that a 2 pCi/m²s standard may be more difficult to achieve than we originally believed. The specific alternatives we analyzed are described in detail in the FEIS. They ranged from controlling emissions to 2 pCi/m²s to providing only a minimal cover that we estimate would, on the average, reduce total radon emissions by half (to final values ranging from 40 pCi/m²s to 500 pCi/m²s, depending upon the site.) Estimated disposal costs for these options (excluding DOE overhead and the cost of moving piles) range from 50 to 195 million dollars. The costs for the revised standard of 20 pCi/m²s were estimated as 95 million dollars; this is approximately 45 million dollars less than for the proposed standard.

We have concluded that this revised standard will provide excellent protection of public health, safety, and the environment. Control measures designed to meet this standard will prevent misuse and protect piles from erosion by providing adequate isolation of tailings. The standard provides more than 96% of the reduction of the potential for lung cancer from radon emissions provided by the proposed standard. Under the revised emission limit, the excess risk to the most exposed individual would be reduced to a few chances in a thousand. In addition, it provides this protection at a substantial cost reduction

compared to the originally proposed standard (including the modification of the longevity requirement, the combined saving is approximately 95 million dollars). The revised emission limit should also be high enough to remove any concern associated with confusing radon from tailings with radon emitted from normal soils (typically up to 1 pCi/m^{2}s), and can be readily achieved through the use of a wider variety of earthen materials than the proposed standards.

We conclude from our analysis that a higher emission standard, such as 100 pCi/m^{2}s, would not achieve the above objectives to an acceptable degree. It would result in a five times greater risk to individuals living near a tailings pile and a similar increase in the impact from radon emissions on local, regional, and national populations (to 20% of the total risk from uncontrolled piles). The control measures required to meet such a less restrictive standard would provide significantly less isolation against intrusion and protection against erosion. The further cost reduction compared to the final standard would be relatively small (approximately 20 million dollars).

The Department of Energy, in the course of the consultations that Section 206 of the Act requires before we promulgate final standards, expressed its strong preference for an ambient air concentration standard rather than an emission standard. Therefore, through calculations described in the FEIS, we determined an alternative standard expressed as a radon concentration at the *edge of the tailings* that we believe would require basically the same level of control as the 20 pCi/m^{2}s emission standard. Applying a concentration standard at the edge of the tailings resolves our concerns about applying it at a site boundary. A limit applied at a site boundary would permit varying effectiveness of cover, depending on the choice of location of the boundary, and compliance would depend on indefinite maintenance of the boundary. How-

ever, a radon concentration standard at any position that is defined in terms of its relation to the tailings has a fixed relationship to radon releases and compliance does not depend on institutional maintenance of a fence.

Calculations can be used to estimate the values of the annual average radon concentrations at various distances from tailings piles with a given emission rate. Considering the uncertainties in such calculations, we are confident that designing control systems to keep the maximum annual average radon concentration at the edges of the tailings below 0.5 pCi/l will provide approximately the same overall health protection as designing them for an average emission rate of 20 pCi/m^{2}s. Under either form of the radon limit the radon concentration due to a pile will be well below the background level at any residence near the disposal site. The final standard contains both forms of radon limit, as approximately equivalent alternatives.

3. Avoiding Contamination of Water. Commenters expressed concern that the proposed requirements for protection of water are unnecessarily restrictive, are impractical or too costly to implement, or incorporate numerical values that had not been adequately justified. Some argued that water protection should be handled on a site-specific basis, that general standards were not necessary, and that water quality standards were not an appropriate basis for these regulations. Other comments expressed the opposite view that the proposed standards did not provide sufficient protection, that already degraded ground water should be cleaned up, or that numerical values should be included for additional toxic elements.

We have carefully reviewed available data on contamination of ground water at the designated sites. Studies of these sites are not yet conclusive, but they provide little evidence of recent movement of contaminants into ground water, and there is some evidence that the geochemical setting may inhibit contaminants from entering usable

ground water at two sites where there might otherwise be a problem (Salt Lake City and Canonsburg). The proposed standards might be difficult to impleemnt at certain sites because our ability to perform definitive hydrological assessments is limited. That is, they could lead to decisions to use very expensive control methods, such as moving piles to new sites and installing liners, even though no substantial threat to ground water is demonstrated. We also believe that minor degradation of ground water may be acceptable, such as for water of already inadequate quality for existing or probable uses, or for very small aquifers.

Finally, we agree that there is uncertainty associated with the appropriateness of both the toxic elements selected and the numerical values specified in the proposed standards, which were drawn mainly from existing national water quality standards for surface water and public drinking water supplies.

In summary, although a few sites appear to have some existing ground water contamination, probably due to dewatering of process liquids from the tailings, we believe there is a low probability of additional contamination at most of the sites. The remedial program should provide for adequate hydrological and geochemical surveys of each site as a basis for determining whether specific water protection or cleanup measures should be applied. Whether or not it is feasible or practical to restore an aquifer and to what degree will depend on site-specific factors, including the aquifer's hydrogeologic setting, the cost, the present and future value of the aquifer as a water resource, the availability of alternative supplies, and the degree to which human exposure is likely to occur.

We do not believe that the existing evidence indicates that ground water contamination from inactive mill tailings is or will be a matter of regulatory concern. We have decided, therefore, not to establish general substan-

tive standards on this subject. Should evidence be found that shows that this judgment is in error, we will consider the need for further rulemaking procedures.

A possible alternative to the above course of action is for us to establish a general regulatory mechanism for others to use in deciding, on a site-specific basis, whether a ground water problem exists and, if so, what remedial action is appropriate. Such a nonsubstantive, or procedural, mechanism would resemble that established by our regulations implementing the Solid Waste Disposal Act, as amended (47 FR 32274, July 26, 1982). In this connection, the Uranium Mill Tailings Radiation Control Act reflects the desire of Congress (in Section 206) that EPA's standards be consistent, to the maximum extent practicable, with the Solid Waste Disposal Act. It also requires NRC to concur in DOE's remedial actions at each site (in Section 108) and to issue licenses for these sites (in Section 104) that may encompass any ". . . monitoring, maintenance, or emergency measures necessary to protect public health and safety." These functions are consistent with those embodied in EPA's above-referenced regulations. We have decided not to adopt this alternative, because we believe that the devising of any necessary such mechanisms for application under this Act can more appropriately be left to the NRC and DOE.

If any existing contamination or potential for future ground water contamination is present we have provided, therefore, in the implementation section of these standards, that judgments on the possible need for monitoring or remedial actions should be guided by relevant considerations described in EPA's hazardous waste management system, and by relevant State and Federal Water Quality Criteria for existing and anticipated uses of the aquifer. Decisions to undertake remediation should consider the costs and benefits of possible remedial and control measures, including the extent and usefulness of the aquifer.

We have also concluded that the same approach is appropriate to surface water, which should be adequately protected in any case by any control measures meeting the standards for longevity and radon emission.

C. The Standards for Cleanup of Tailings

1. Radium-226 in Soil. Comments about the cleanup standard for radium-226 in soil dealt primarily with the proposed numerical value of the standard and perceived difficulty of measurement to show conformance. Many comments expressed the view that there was no justification for a standard as low as 5 pCi/g and that a higher value would be most cost-effective. Recommended values ranged from 10-30 pCi/g.

The purpose of this standard is to limit the risk from inhalation of radon decay products in houses built on land contaminated with tailings, and to limit gamma radiation exposure of people using contaminated land. We estimate that each increase of 0.01 WL inside a house increases the risk of lung cancer to each of its inhabitants by something like one-half to one in a hundred, for an assumed lifetime of residency. The infiltration of radon in soil gas directly into a house is by far the largest contributor to indoor radon, and we estimate that soil extensively contaminated at a level of 5 pCi/g radium can readily lead to indoor levels of radon decay products of 0.02 WL. Because the risks from soils contaminated with radium-226 are potentially so great, the proposed standard was set at a level as close to background as we believed reasonable, taking into consideration the difficulties in measuring this level and distinguishing it from natural background.

We have examined the costs and benefits of alternative standards ranging from 5 to 30 pCi/g. These are described in detail in the FEIS. Total cleanup costs are less than 10% to 20% of the total costs of disposal of tailings piles for all the alternatives considered. Costs for cleanup of windblown tailings from land surfaces are sensitive to the standard, because the area to be cleaned up varies

approximately inversely with the limit selected. Costs for removal of buried tailings are not sensitive to the standard, since the amount to be removed varies only slightly with the limit selected. That is, we concluded most buried tailings would be removed under any of the alternatives considered. We also considered the difficulty of measuring various thicknesses of surface contamination, and in identifying and measuring contamination due to buried tailings. Detection of buried tailings could be difficult. However, buried tailings, as opposed to surface contamination (usually windblown and diluted with soil), can be effectively located using a higher detection limit than the proposed standard of 5 pCi/g. Based on these analyses, we have modified the standard for surface contamination of soil (5 pCi/g) from an average over the top 5 cm of soil to an average over the top 15 cm of soil; and revised the standard for subsurface contamination from 5 pCi/g to 15 pCi/g (still averaged over any 15 cm layer of soil). We believe these standards will result in essentially the same degree of cleanup, and will be simpler to implement.

For tailings transported by man to offsite properties, the hazard varies with the amount of tailings involved and their location. The proposed standard did not provide for exemption of locations posing a low hazard. The final standard requires cleanup of contamination only when the amount and location of tailings poses a clear present or future hazard, and provides criteria to assist this determination. We estimate that perhaps more than half of the identified locations of such contamination do not present a hazard sufficient to warrant cleanup, at an estimated saving of 24 million dollars.

Some comments expressed the view that measuring radium-226 and distinguishing residual radioactive materials from natural background at the levels proposed would be difficult and costly, and that many samples would have to be collected and analyzed to show compliance with the standards. The changes we have made

make determination of compliance with the standard easier and less costly. In addition, we have provided guidance in this Notice and the FEIS on implementation of the standards, to clarify our intent that unnecessarily stringent (and costly) verification that the standards have been achieved should be avoided.

2. Radon Decay Products in Buildings. Some comments expressd the view that the proposed indoor radon decay product standard of 0.015 WL would be difficult and costly to implement, because it is within the upper range of levels that commonly occur in houses due to natural causes. For example, it might be necessary to distinguish whether the standard is exceeded because of the presence of tailings or because of anomalies in the natural background. This could result in costly and unnecessary remedial actions, or in the frequent use of an exceptions procedure. These comments recommended that we raise this standard to a more cost-effective value that can be more easily distinguished from naturally-occurring levels.

We have considered these arguments and re-examined the costs and benefits of alternative standards. We used the data from the Grand Junction, Colorado, remedial program for contaminated buildings to assist this evaluation. Reduction of radon decay products in existing buildings is probably the most cost-effective of all types of remedial actions for tailings, because [sic] the high risk associated with indoor radon decay products. Based on these evaluations, the standard has been revised upward only slightly so as to facilitate implementation and to more closely conform to other related standards. Under the final standard the objective of remedial actions is to achieve an indoor radon decay product concentration of 0.02 WL. For circumstances where remedial action has been performed and it would be unreasonably difficult and costly to reduce the level below 0.03 WL, the remedial action may be terminated at this level without a specific finding of the need

for an exception. However, we have also sought to avoid excessive costs by encouraging the use of active measures (such as heat exchangers, air cleaners, and sealants) to meet the objective of 0.02 WL when further removal of tailings to achieve levels below 0.03 WL is impractical. We believe the final standard deals adequately with complications introduced by the presence of any high concentration of naturally-occurring radionuclides, and avoids unnecessary and costly remedial actions that produce only marginal improvements.

D. Reducing Regulatory Burdens. Some commenters suggested that the proposed standards should be flexible to take account of unusual circumstances, site-specific factors, and any complications due to high natural background levels. These commenters recommended that this be accomplished by raising the numerical limits, establishing different standards for unusual circumstances, or by expressing the standards as a range of values.

We agree that it is appropriate and desirable to take into account, as far as practical, different circumstances. In addition, we believe that regulations should be easy to carry out and not contain unnecessary procedural requirements. We have encouraged the implementing agencies to do this in our "Guidance for Implementation" as described below. We have also changed the procedures for situations in which it would be unreasonable to satisfy the standards from an "exceptions" process to one in which the implementing agencies apply "Supplemental Standards." This is also described below. Finally, the numerical limits of some of the standards have been raised; this will assure that they are more readily distinguishable from background levels.

IV. Implementation.

The Act requires the Secretary of Energy to select and perform the remedial actions needed to implement these standards, with the full participation of any State that

shares the cost, with the concurrence of the Nuclear Regulatory Commission, and in consultation, when appropriate, with affected Indian tribes and the Secretary of the Interior.

The cost of remedial action will be borne by the Federal Government and the States as prescribed by the Act. Control and stabilization remedial activities are large scale undertakings for which there is relatively little experience. Although preliminary engineering assessments have been performed, specific engineering requirements and costs to meet the standards at each site have yet to be determined. We believe control and stabilization costs (including DOE overhead) averaging about 10-12 million (1981) dollars per tailings pile are most likely. For some sites, this cost may be partly offset by recovered land values or through provisions of the Act for recovery of uranium or other minerals through reprocessing the tailings prior to performing remedial actions.

A. Guidance for Implementation

Conditions at the inactive processing sites vary greatly, and engineering experience with some of the required remedial actions is limited. It is our objective that implementation of these standards be consistent with the assumptions we have made in deriving them. We are therefore providing "Guidance for Implementation" to avoid needless expense which may result from uncertainty or confusion as to what level of protection the standards are intended to achieve.

The standard for control and stabilization of tailings piles is primarily intended as a design standard. Implementation will require a judgment that the method chosen provides a reasonable expectation that the provisions of the standard will be met, to the extent reasonably achievable, for up to 1000 years, and, in any case, for at least 200 years. This judgment will necessarily be based on

site-specific analyses of the properties of the sites, candidate control systems, and the potential effects of natural processes over time, and, therefore, the measures required to satisfy the standard will vary from site to site. We expect that computational models, theories, and expert judgment will be the major tools in deciding that a proposed control system will adequately satisfy the standard. Post-remediation monitoring will not be required to show compliance, but may serve a useful role in determining whether the anticipated performance of the control system is achieved.

The purpose of our cleanup standards is to provide the maximum reasonable protection of public health and the environment. Costs incurred by remedial actions should be directed toward this purpose. We intend the standards to be implemented using search and verification procedures whose cost and technical requirements are reasonable. For example, since we intend the cleanup standards for buildings to protect people, measurements in such locations as small crawl spaces and furnace rooms may often be inappropriate. Remedial action decisions should be based on radiation levels in the parts of buildings where people spend substantial amounts of time. The standards for cleanup of land are designed to limit the exposure of people to gamma radiation, and to limit the level of radon decay products in buildings that might later be built on the land. In most circumstances, no significant harm would be caused by not cleaning up small areas of land contaminated by tailings. Similarly, it would be unreasonable to require expensive detailed proof that all the tailings below the surface of open lands had been removed. Procedures that provide a reasonable assurance of compliance with the standards will be adequate. Where measurements are necessary to determine compliance with the cleanup standards, they should be performed within the accuracy of presently available field

and laboratory measurement capabilities and in conjunction with reasonable survey and sampling procedures designed to minimize the cost of verification. We are confident that DOE and NRC, in consultation with EPA and the States, will adopt implementation procedures consistent with our intent in establishing these standards.

B. Supplemental Standards

The varied conditions at the designated sites and limited experience with remedial actions make it appropriate that EPA allow adjustment of the standards where circumstances require. We believe that, in most cases, our final standards are adequately protective and can be implemented at reasonable cost. However, the standards could be too strict in some applications. We anticipate that such circumstances might occur. We originally proposed to deal with this through an "exceptions" procedure which would relax standards when certain criteria were satisfied. We agree with the comments, however, that the proposed procedure was unnecessarily burdensome to apply.

In the final regulations we have eliminated this procedure and replaced it with a simplified procedure for applying "supplemental standards." This is a more effective means of accomplishing our original purpose. An additional significant change in the proposed criteria for exceptions is the addition of criterion 192.21(c), which relaxes the requirement for cleanup of land at off-site locations when residual radioactive materials are not clearly hazardous and cleanup costs are unreasonably high. The category of contamination was not adequately addressed in the proposals.

Regulatory Impact Analysis

Under Executive Order 12291, EPA must judge whether a regulation is "Major" and therefore subject to the requirement of a Regulatory Impact Analysis. That order requires such an analysis if the regulations would result

in (1) an annual effect on the economy of $100 million or more; (2) a major increase in costs or prices for consumers, individual industries, Federal, State, or local government agencies or geographic regions; or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or on the ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.

This regulation is not Major, because we expect the costs of the remedial action program in any calendar year to be less than $100 million; States bear only 10% of these costs and there are no anticipated major effects on costs or prices for others; and we anticipate no significant adverse effects on domestic or foreign competition, employment, investment, productivity, or innovation. The costs of these standards are discussed in the FEIS.

This regulation was submitted to the Office of Management and Budget for review as required by Executive Order 12291.

This regulation will not have a significant effect on a substantial number of small entities, as specified under Section 605 of the Regulatory Flexibility Act, because there are no small entities subject to this regulation.

Dated: December 15, 1982.

Anne M. Gorsuch,

Administrator.

List of Subjects in 40 CFR Part 192

Environmental protection; Radiation protection; Uranium.

In 40 CFR Chapter I, Part 192 is revised to read as follows:

PART 192—HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM MILL TAILINGS

Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

Sec.

192.00 Applicability.
192.01 Definitions.
192.02 Standards.

Subpart B—Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

192.10 Applicability.
192.11 Definitions.
192.12 Standards.

Subpart C—Implementation

192.20 Guidance for implementation.
192.21 Criteria for applying supplemental standards.
192.22 Supplemental standards.
192.23 Effective date.

Authority: Section 275 of the Atomic Energy Act of 1954, 42 U.S.C. 2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604.

Subpart A—Standards for the Control of Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.00 Applicability

This subpart applies to the control of residual radioactive material at designated processing or depository sites under Section 108 of the Uranium Mill Tailings Radiation Control Act of 1978 (henceforth designated

"the Act"), and to restoration of such sites following any use of subsurface minerals under Section 104(h) of the Act.

§ 192.01 Definitions

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title I of the Act.

(b) *Remedial* action means any action performed under Section 108 of the Act.

(c) *Control* means any remedial action intended to stabilize, inhibit future misuse of, or reduce emissions or effluents from residual radioactive materials.

(d) *Disposal site* means the region within the smallest perimeter of residual radioactive material (excluding cover materials) following completion of control activties.

(e) *Depository site* means a disposal site (other than a processing site) selected under Section 104(b) or 105 (b) of the Act.

(f) *Curie* (Ci) means the amount of radioactive material that produces 37 billion nuclear transformations per second. One picocurie (pCi) = 10^{-12}Ci.

§ 192.02 Standards

Control shall be designed [4] to:

(a) Be effective for up to one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(b) Provide reasonable assurance that releases of radon-222 from residual radioactive material to the atmosphere will not:

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[4] Because the standard applies to design, monitoring after disposal is not required to demonstrate compliance.

(1) Expect an average[5] release rate of 20 picocuries per square meter per second, *or*

(2) Increase the annual average concentration of radon-222 in air at or above any location outside the disposal site by more than one-half picocurie per liter.

Subpart B—Standards for Cleanup of Land and Buildings Contaminated with Residual Radioactive Materials from Inactive Uranium Processing Sites

§ 192.10 Applicability

This subpart applies to land and buildings that are part of any processing site designated by the Secretary of Energy under Section 102 of the Act. Section 101 of the Act, states, in part, the "processing site" means—

(a) Any site, including the mill, containing residual radioactive materials at which all or substantially all of the uranium was produced for sale to any Federal agency prior to January 1, 1971, under a contract with any Federal agency, except in the case of a site at or near Slick Rock, Colorado, unless—

(1) Such site was owned or controlled as of January 1, 1978, or is thereafter owned or controlled, by any Federal agency, or

(2) A license (issued by the (Nuclear Regulatory) Commission or its predecessor agency under the Atomic Energy Act of 1954 or by a State as permitted under Section 274 of such Act) for the production at site of

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[5] This average shall apply over the entire surface of the disposal site and over at least a one-year period. Radon will come from both residual radioactive materials and from materials covering them. Radon emissions from the covering materials should be estimated as part of developing a remedial action plan for each site. The standard, however, applies only to emissions from residual radioactive materials to the atmosphere.

any uranium or thorium product derived from ores is in effect on January 1, 1978, or is issued or renewed after such date; and

(b) Any other real property or improvement thereon which—

(1) Is in the vicinity of such site, and

(2) Is determined by the Secretary, in consultation with the Commission, to be contaminated with residual radioactive materials derived from such site.

§ 192.11 Definitions

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as defined in Title I of the Act or in Subpart A.

(b) "Land" means any surface or subsurface land that is not part of a disposal site and is not covered by an occupiable building.

(c) "Working Level" (WL) means any combination of short-lived radon decay products in one liter of air that will result in the ultimate emission of alpha particles with a total energy of 130 billion electron volts.

(d) "Soil" means all unconsolidated materials normally found on or near the surface of the earth including, but not limited to, silts, clays, sands, gravel, and small rocks.

§ 192.12 Standards

Remedial actions shall be conducted so as to provide reasonable assurance that, *as a result of residual radioactive materials from any designated processing site:*

(a) The concentration of radium-226 in land averaged over any area of 100 square meters shall not exceed the background level by more than—

(1) 5 pCi/g, averaged over the first 15 cm of soil below the surface, and

(2) 15 pCi/g, averaged over 15 cm thick layers of soil more than 15 cm below the surface.

(b) In any occupied or habitable building—

(1) The objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL, and

(2) The level of gamma radiation shall not exceed the background level by more than 20 microroentgens per hour.

Subpart C—Implementation

§ 192.20 Guidance for implementation

Section 108 of the Act requires the Secretary of Energy to select and perform remedial actions with the concurrence of the Nuclear Regulatory Commission and the full participation of any State that pays part of the cost, and in consultation, as appropriate, with affected Indian Tribes and the Secretary of the Interior. These parties, in their respective roles under Section 108, are referred to hereafter as "the implementing agencies." The implementing agencies shall establish methods and procedures to provide "reasonable assurance" that the provisions of Subparts A and B are satisfied. This should be done as appropriate through use of analytic models and site-specific analyses, in the case of Subpart A, and for Subpart B through measurements performed within the accuracy of currently available types of field and laboratory instruments in conjunction with reasonable survey and sampling procedures. These methods and procedures

may be varied to suit conditions at specific sites. In particular:

(a)(1) The purpose of Subpart A is to provide for long-term stabilization and isolation in order to inhibit misuse and spreading of residual radioactive materials, control releases of radon to air, and protect water. Subpart A may be implemented through analysis of the physical properties of the site and the control system and projection of the effects of natural processes over time. Events and processes that could significantly affect the average radon release rate from the entire disposal site should be considered. Phenomena that are localized or temporary, such as local cracking or burrowing of rodents, need to be taken into account only if their cumulative effect would be significant in determining compliance with the standard. Computational models, theories, and prevalent expert judgment may be used to decide that a control system design will satisfy the standard. The numerical range provided in the standard for the longevity of the effectiveness of the control of residual radioactive materials allows for consideration of the various factors affecting the longevity of control and stabilization methods and their costs. These factors have different levels of predictability and may vary for the different sites.

(2) Protection of water should be considered in the analysis for reasonable assurance of compliance with the provisions of § 192.02. Protection of water should be considered on a case-specific basis, drawing on hydrological and geochemical surveys and all other relevant data. The hydrologic and geologic assessment to be conducted at each site should include a monitoring program sufficient to establish background ground water quality through one or more upgradient wells, and identify the presence and movement of plumes associated with the tailings piles.

(3) If contaminants have been released from a tailings pile, an assessment of the location of the contami-

nants and the rate and direction of movement of contaminated ground water, as well as its relative contamination, should be made. In addition, the assessment should identify the attenuative capacity of the unsaturated and saturated zone to determine the extent of plume movement. Judgments on the possible need for remedial or protective actions for groundwater aquifers should be guided by relevant considerations described in EPA's hazardous waste management system (47 FR 32274, July 26, 1982) and by relevant State and Federal Water Quality Criteria for anticipated or existing uses of water over the term of the statbilization. The decision on whether to institute remedial action, what specific action to take, and to what levels an aquifer should be protected or restored should be made on a case-by-case basis taking into account such factors as technical feasibility of improving the aquifer in its hydrogeologic setting, the cost of applicable restorative or protective programs, the present and future value of the aquifer as a water resource, the availability of alternative water supplies, and the degree to which human exposure is likely to occur.

(b)(1) Compliance with Subpart B, to the extent practical, should be demonstrated through radiation surveys. Such surveys may, if appropriate, be restricted to locations likely to contain residual radioactive materials. These surveys should be designed to provide for compliance averaged over limited areas rather than point-by-point compliance with the standards. In most cases, measurement of gamma radiation exposure rates above and below the land surface can be used to show compliance with § 192.12(a). Protocols for making such measurements should be based on realistic radium distributions near the surface rather than extremes rarely encountered.

(2) In § 192.12(a), "background level" refers to the native radium concentration in soil. Since this may not

be determinable in the presence of contamination by residual radioactive materials, a surrogate "background level" may be established by simple direct or indirect (e.g., gamma radiation) measurements performed nearby but outside of the contaminated location.

(3) Compliance with § 192.12(b) may be demonstrated by methods that the Department of Energy has approved for use under Pub. L. 92-314 (10 CFR 712), or by other methods that the implementing agencies determine are adequate. Residual radioactive materials should be removed from buildings exceeding 0.03 WL so that future replacement buildings will not pose a hazard [unless removal is not practical—see § 192.21(c)]. However, sealants, filtration, and ventilation devices may provide reasonable assurance of reductions from 0.03 WL to below 0.02 WL. In unusual cases, indoor radiation may exceed the levels specified in § 192.12(b) due to sources other than residual radioactive materials. Remedial actions are not required in order to comply with the standard when there is reasonable assurance that residual radioactive materials are not the cause of such an excess.

§ 192.21 Criteria for applying supplemental standards

The implementing agencies may (and in the case of Subsection (f) shall) apply standards under § 192.22 in lieu of the standards of Subparts A or B if they determine that any of the following circumstances exists:

(a) Remedial actions required to satisfy Subparts A or B would pose a clear and present risk of injury to workers or to members of the public, notwithstanding reasonable measures to avoid or reduce risk.

(b) Remedial actions to satisfy the cleanup standards for land, § 192.12(a), or the acquisition of minimum materials required for control to satisfy § 192.02(b), would, notwithstanding reasonable measures to limit damage,

directly produce environmental harm that is clearly excessive compared to the health benefits to persons living on or near the site, now or in the future. A clear excess of environmental harm is harm that is long-term, manifest, and grossly disproportionate to health benefits that may reasonably be anticipated.

(c) The estimated cost of remedial action to satisfy § 192.12(a) at a "vicinity" site (described under Sec. 101(6)(B) of the Act) is unreasonably high relative to the long-term benefits, and the residual radioactive materials do not pose a clear present or future hazard. The likelihood that buildings will be erected or that people will spend long periods of time at such a vicinity site should be considered in evaluating this hazard. Remedial action will generally not be necessary where residual radioactive materials have been placed semi-permanently in a location where site-specific factors limit their hazard and from which they are costly or difficult to remove, or where only minor quantities of residual radioactive materials are involved. Examples are residual radioactive materials under hard surface public roads and sidewalks, around public sewer lines, or in fence post foundations. Supplemental standards should not be applied at such sites, however, if individuals are likely to be exposed for long periods of time to radiation from such materials at levels above those that would prevail under § 192.12(a).

(d) The cost of a remedial action for cleanup of a building under § 192.12(b) is clearly unreasonably high relative to the benefits. Factors that should be included in this judgment are the anticipated period of occupancy, the incremental radiation level that would be affected by the remedial action, the residual useful lifetime of the building, the potential for future construction at the site, and the applicability of less costly remedial methods than removal of residual radioactive materials.

(e) There is no known remedial action.

(f) Radionuclides other than radium-226 and its decay products are present in sufficient quantity and concentration to constitute a significant radiation hazard from residual radioactive materials.

§ 192.22 Supplemental standards

Federal agencies implementing Subparts A and B may in lieu thereof proceed pursuant to this section with respect to generic or individual situations meeting the eligibility requirements of § 192.21.

(a) When one or more of the criteria of § 192.21(a) through (e) applies, the implementing agencies shall select and perform remedial actions that come as close to meeting the otherwise applicable standard as is reasonable under the circumstances.

(b) When § 192.21(f) applies, remedial actions shall, in addition to satisfying the standards of Subparts A and B, reduce other residual radioactivity to levels that are as low as is reasonably achievable.

(c) The implementing agencies may make general determinations concerning remedial actions under this Section that will apply to all locations with specified characteristics, or they may make a determination for a specific location. When remedial actions are proposed under this Section for a specific location, the Department of Energy shall inform any private owners and occupants of the affected location and solicit their comments. The Department of Energy shall provide any such comments to the other implementing agencies. The Department of Energy shall also periodically inform the Environmental Protection Agency of both general and individual determinations under the provisions of this section.

§ 192.23 Effective date.

Subparts A, B, and C shall be effective March 7, 1983.

APPENDIX D

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 192

[AD-FRL-2431-8]

Environmental Standards for Uranium and Thorium Mill Tailings at Licensed Commercial Processing Sites

AGENCY: Environmental Protection Agency.

ACTION: Final rule.

SUMMARY: These are final health and environmental standards to govern stabilization and control of byproduct materials (primarily mill tailings) at licensed commercial uranium and thorium processing sites. These standards were developed pursuant to Section 275 of the Atomic Energy Act (42 U.S.C. 2022), as added by Section 206 of Pub. L. 95-604, the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA).

The standards apply to tailings at locations that are licensed by the Nuclear Regulatory Commission (NRC) or the States under Title II of the UMTRCA. The standards for disposal of tailings require stabilization so that the health hazards associated with tailings will be controlled and limited for at least one thousand years. They require that disposal be designed to limit releases of radon to 20 picocuries per square meter per second, averaged over the surface of the disposed tailings, and require measures to avoid releases of radionuclides and other hazardous substances from tailings to water. The standards for tailings at operating mills, prior to final disposal, add two elements and a measure of radioactivity to the ground water protection requirements now specified under the Solid Waste Disposal Act, as amended. Existing EPA regulations and Federal Radiation Protection Guidance

currently applicable to tailings remain unchanged. The Agency will monitor continuing development of technical and economic information as the Department of Energy proceeds with disposal of the inactive tailings piles, and revise these standards if this information suggests that modifications are warranted.

This notice summarizes the comments received on proposed standards published on April 29, 1983, and provides a summary of the Agency's consideration of major comments. Detailed responses to comments are contained in the Final Environmental Impact Statement.

DATE: these final standards take effect on December 6, 1983.

ADDRESSES: *Background Documents*—Background information is given in the Final Environmental Impact Statement for Standards for the Control of Byproduct Materials from Uranium Ore Processing (40 CFR Part 192), EPA 520/1-83-008 (FEIS) and the Regulatory Impact Analysis of Environmental Standards for Uranium Mill Tailings at Active Sites, EPA 520/1-83-010 (RIA). Single copies of the FEIS and the RIA, as available, may be obtained from the Program Management Office (ANR-458), Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C. 20460; telephone number (703) 557-9351.

Docket: Docket Number A-82-26 contains the rulemaking record. The docket is available for public inspection between 8:00 a.m. and 4:00 p.m., Monday through Friday, at EPA's Central Docket Section (LE-130), West Tower Lobby, Gallery I, 401 M Street, SW., Washington, D.C. 20460. A reasonable fee may be charged for copying.

FOR FURTHER INFORMATION CONTACT: Mr. Jack Russell, Guides and Criteria Branch (ANR-460), Office of Radiation Programs, U.S. Environmental Protection

Agency, Washington, D.C. 20460; telephone number (703) 557-8224.

SUPPLEMENTARY INFORMATION:

I. Introduction

On November 8, 1978, Congress enacted Pub. L. 95-604, the Uranium Mill Tailings Radiation Control Act of 1978 (henceforth designated "UMTRCA"). In the Act, Congress stated its finding that uranium mill tailings "* * * may pose a potential and significant radiation health hazard to the public, * * * and * * * that every reasonable effort should be made to provide for stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings." The Administrator of the Environmental Protection Agency (EPA) was directed to set "* * * standards of general application for the protection of the public health, safety, and the environment * * *" to govern this process of stabilization, disposal, and control.

UMTRCA established two programs to protect public health, safety, and the environment from uranium mill tailings, one for certain designated sites which are now inactive (i.e., at which all milling has stopped and which are not under license) and another for active sites (those sites licensed by the Nuclear Regulatory Commission (NRC) or the State in which the site is located, when this State is an Agreement State of the NRC under Section 274 of the Atomic Energy Act).

Tailings at the inactive uranium milling sites are defined in UMTRCA as residual radioactive materials. The program for inactive sites covers the disposal of tailings and the cleanup of onsite and offsite locations contaminated with tailings. Final cleanup and disposal standards for the inactive sites were published by EPA on January

5, 1983 (48 FR 590). The U.S. Department of Energy (DOE) is responsible for carrying out these activities in conformance with these standards, with the concurrence of the NRC, and in cooperation with the States.

Tailings at active uranium milling sites are defined in UMTRCA as uranium byproduct materials. The program for active sites covers the final disposal of tailings and the control of effluents and emissions during and after milling operations. UMTRCA requires EPA to establish standards for this program, and that standards for nonradioactive hazards protect human health and the environment in a manner consistent with standards established under Subtitle C of the Solid Waste Disposal Act, as amended (SWDA). The NRC or the licensing Agreement State is responsible for assuring compliance with the standards at active mill sites.

On January 4, 1983, Congress amended UMTRCA to provide additional guidance on the matters to be considered in establishing these standards and to establish new deadlines for their promulgation: "In establishing such standards, the Administrator shall consider the risk to the public health, safety, and the environment, the environmental and economic costs of applying such standards, and such other factors as the Administrator determines to be appropriate." The Act (Pub. L. 96-415) established a deadline of October 1, 1983 for promulgation of the standards. These final standards conform to the above requirements.

II. Summary of the Final Rule

This final rule modifies and clarifies some of the provisions of the proposed standards because of information obtained during the comment period and at public hearings (May 31, 1983, in Washington, and June 15-16, 1983, in Denver).

EPA received a wide range of comments on the proposed standards and the supporting documents. Several hundred letters were received and 34 individuals testified and/or submitted comments at the public hearings. Comments were received from a broad spectrum of participants, including private citizens, public interest groups, members of the scientific community, representatives of industry, and State and Federal agencies. EPA has carefully reviewed and considered these comments in preparing the FEIS, the RIA, and in developing these final standards. EPA's responses to major comments are discussed in this "preamble" and comments are discussed in detail in the FEIS. Section III of this preamble summarizes the major considerations upon which these standards are based, and in Section IV we discuss the major issues raised in public comments, our responses to them, and the specific changes in the standards that resulted from our consideration of public comments.

These standards are divided into two parts. The first part applies to management of tailings during the active life of the pile, and during the subsequent "closure period," i.e., after cessation of operations but prior to completion of final disposal, including the period when the tailings are drying out. These are standards that govern milling operations.

The second part specifies the conditions to be achieved by final disposal. Those standards guide the activities carried out during the closure period to assure adequate final disposal. They are standards that govern the design of disposal systems.

The major provisions of the final rule are summarized in the following list, with changes from the proposed rule noted. The final rule:

(1) Applies to management and disposal of byproduct materials at sites where ore is processed primarily to recover its uranium or thorium content.

(2) Applies to the regulatory activities of NRC and the States that license uranium or thorium mills.

(3) Requires that ground water be protected from uranium tailings to background or drinking water levels to preserve its future uses by incorporating the Solid Waste Disposal Act (SWDA) rules.

(4) Requires that disposal of uranium tailings piles be designed so that, after disposal, radon emissions will be limited to 20 picocuries per square meter per second.

(5) Requires that the disposal of uranium tailings be designed to maintain its integrity, in most cases, for at least 1000 years.

(6) Requires liners be used for ground water protection.

(7) Permits the regulatory agency to issue alternate ground water standards when the normally required levels will be satisfied no further from the edge of tailings than the site boundary, or within 500 meters of the tailings, whichever is less (instead of requiring EPA concurrence, as proposed).

(8) Requires corrective action to restore groundwater to its background quality to be in place within 18 months of a determination of noncompliance (instead of the proposed 12 months).

(9) Requires equivalent levels of protection for wet sites (where precipitation exceeds evapotranspiration) as for dry sites (by deleting the exception permitting a nonpermeable cap at wet sites).

(10) Requires the same level of protection at all sites regardless of current local populations.

(11) Establishes equivalent requirements for thorium byproduct materials.

III. Summary of Background Information

A. The Uranium Industry

The major deposits of high-grade uranium ores in the United States are located in the Colorado Plateau, the Wyoming Basins, and the Gulf Coast Plain of Texas. Most ore is mined by either underground or open-pit methods. At the mill the ore is first crushed, blended, and ground to the proper size for the leaching process which extracts uranium. Several leaching processes are used, including acid, alkaline and a combination of the two. After uranium is leached from the ore it is concentrated from the leach liquor through ion exchange or solvent extraction. The concentrated uranium is then stripped or extracted from the concentrating medium, precipitated, dried, and packaged. The depleted ore, in the form of tailings, is pumped to a tailings pile as a slurry mixed with water.

Since the uranium content of ore averages only about 0.15 percent, essentially all the bulk of ore mined and processed is contained in the tailings. These wastes contain significant quantities of radioactive uranium decay products, including thorium-230, radium-226, and decay products of radon-222. Tailings can also contain significant quantities of other hazardous substances, depending upon the source of the ore and the reagents used in the milling process. Most of the tailings are a sand-like material and, because such materials are attractive for use in construction and soil conditioning, have been improperly used in the past, thereby contributing to spreading the radioactive materials offsite. Tailings materials are also subject to wind and water erosion, which may spread radioactive materials offsite.

As of January 1983, there were 27 licensed uranium mills, of which only 14 were operating. By early 1983, the amount of stored tailings had reached about 175 million metric tons (MT). The size of individual tailings

piles ranges from about 2 million MT to about 30 million MT.

The future demand for uranium is projected to be almost exclusively for electrical power generation. Based on recent DOE projections, it is estimated that at least an additional 175 million MT of tailings will be generated by the year 2000 in the United States. This projection is for the conventional milling of uranium described above. A small quantity of uranium is also recovered as a secondary product in the extraction of other minerals, such as phosphate and copper, and also by solution (*in situ*) mining methods. Foreign sources of uranium may also influence demand projections for the domestic uranium industry, especially since some foreign deposits are richer in uranium, which permits lower pricing.

The United States Government purchased large quantities of uranium, primarily for use in defense programs, from 1943 to 1970. Many of the producers of this uranium continued operating after 1970 to supply the commercial demand for uranium. In most cases the tailings from Government and commercial purchases were mixed and stored in the same pile. These mixed tailings are now referred to as "commingled" tailings. There are about 51 million MT of defense-related tailings commingled with approximately 74 million MT of other tailings at 13 of the sites which are now licensed for milling uranium ore.

B. Hazards Associated with Uranium Byproduct Materials

The most important of the hazardous constituents of uranium mill tailings is radium, which is radioactive. We estimate that currently existing tailings at the licensed sites contain a total of about 90,000 curies [1] of radium.

[1] A curie is the amount of radioactive material that produces 37 billion nuclear transformations (e.g., disintegrations of radium into radon) per second.

Radium, in addition to being hazardous itself, produces radon, a radioactive gas whose decay products can cause lung cancer. Because of the long life of thorium-230 (about 75,000 years half-life), the amount of radium in tailings, and therefore, the rate at which radon is produced, will decay to about 10 percent of the current amount in several hundred thousand years. Other potentially hazardous constituents of tailings include arsenic, molybdenum, selenium, uranium, and, usually in lesser amounts, a variety of other toxic substances. The concentrations of all of these materials vary from pile to pile.

The radioactivity and toxic materials in tailings may cause cancer and other diseases, as well as genetic damage and teratogenic effects. More specifically, tailings are hazardous to man primarily because: (1) Radioactive decay products of radon may be inhaled and increase the risk of lung cancer; (2) individuals may be exposed to gamma radiation from the radioactivity in tailings; and (3) radioactive and toxic materials from tailings may be ingested with food or water. Our analysis shows the first of these hazards to be by far the most important.

As noted above, the radiation hazard from tailings lasts for many hundreds of thousands of years, and some non-radioactive toxic chemicals persist indefinitely. The hazard from uranium tailings therefore must be viewed in two ways. Tailings pose a present hazard to human health. Beyond this immediate but generally limited health threat, the tailings are vulnerable to human misuse and to dispersal by natural forces for an essentially indefinite period. In the long run the future risks to health of indefinitely-extended contamination from misused and dispersed tailings due to inadequate control overshadows the short-term danger to public health. The congressional report accompanying UMTRCA recognized the existence of long-term risks, and expressed the view that the methods used for disposal should not be effective for only a short period of time. It stated: "The committee believes that

uranium mill tailings should be treated * * * in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms * * *" and, in commenting on the Federally-funded program to clean up and dispose of tailings at the inactive sites, it stated "The committee does not want to visit this problem again with additional aid. The remedial action must be done right the first time." (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., Pt. I, p. 17, and Pt. II, p. 40 (1978).)

For the purpose of establishing standards for the protection of the general public from radiation, we assume a linear, nonthreshold dose-effect relationship as a reasonable basis for estimating risks to health. This means we assume that any radiation dose poses some risk and that the risk of low doses is directly proportional to the risk that has been demonstrated at higher doses. We recognize that the data available preclude neither a threshold for some types of damage below which there are no harmful effects, nor the possibility that low doses of gamma radiation may be less harmful to people than the linear model implies. However, the major radiation hazard from tailings arises not from gamma radiation, but rather is due to alpha radiation from inhaled radon decay products. As pointed out by the National Academy of Sciences' (NAS) Advisory Committee on the Biological Effects of Ionizing Radiation (the BEIR Committee) in its 1980 report, for "* * *radiation, such as from internally deposited alpha-emitting radionuclides, the application of the linear hypothesis is less likely to lead to overestimates of risk, and may, in fact, lead to underestimates."

Our quantitative estimates of the risk due to inhalation of radon decay products are based on our review of epidemiological studies, conducted in the United States and in other countries, of underground miners of uranium and other metals who have been exposed to radon decay products. We have also considered reports by scientific groups,

such as *Health Effects of Alpha Emitting Particles in the Respiratory Tract* (1976) and *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (1980) by the NAS; the report of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) entitled *Sources and Effects of Ionizing Radiation* (1977); Report No. 32, *Limits for Inhalation of Radon Daughters by Workers* (1981) of the International Commission on Radiological Protection (ICRP); and *Risk Estimates for the Health Effects of Alpha Radiation*, by D.C. Thomas and K.G. McNeill (1982), a detailed review prepared for the Atomic Energy Control Board of Canada (AECB). Details of our risk estimates are provided in a previous EPA report, *Indoor Radiation Exposure Due to Radium-226 in Florida Phosphate Lands* (EPA 520/4-78-013), and in the FEIS.

Although the studies of underground miners show that there is a significant risk of lung cancer from exposure to radon decay products, there is uncertainty in its magnitude. Our estimates of the risk due to inhalation of radon decay products exceed those of the ICRP and UNSCEAR by a factor of at least two. However, neither group considered continuous exposure for the duration of a person's lifetime nor documented that they properly projected the risk observed to date in groups of underground miners over the balance of their expected lifetimes. These factors were explicitly considered by the 1980 NAS BEIR Committee. Although the NAS Methodology differs from that employed by EPA, their numerical estimates of risk due to lifetime exposure are essentially identical to those of EPA. The most recent and complete assessment of the miner data, that performed for the AECB, yields a result within 20 percent of the EPA value. Numerical estimates of risk by various other observers differ by up to a factor of eight. We also considered the views of these other observers and discuss their results in the FEIS.

The uncertainties in risk estimates for exposure of miners to radon decay products arise from several sources. Exposures of miners were estimated from the time spent in each location in a mine and the measured radon decay product levels at those locations. However, radon decay product measurements were infrequent and often nonexistent for exposures of miners prior to the 1960's. The uncertainty increases when data for miners are used to estimate risk to members of the general public, because there are differences in age, physiology, exposure conditions, and other factors between the two populations.

We must also make numerous assumptions to estimate the radiation dose to individuals and population groups due to uranium mill tailings, and these introduce additional uncertainties. For example, we make risk estimates for individuals who are assumed to reside at the same location for their life spans, and we further assume that people will continue to have the same life expectancy as the U.S. population did in 1970. Nevertheless, we believe the information available supports estimates of risk which are sufficiently reliable to provide an adequate basis for these proposed standards.

It is not possible to reduce the risk to zero for people exposed to radiation or, for that matter, to many other carcinogens. To decide on a reasonable level of incremental residual risk, we evaluated the practicality and benefits of different levels of control. We also considered technical difficulties associated with implementing different levels of control.

Uranium mill tailings can affect man through four principal environmental pathways:

• *Diffusion of radon-222, the decay product of radium-226 tailings into indoor air.* Breathing radon-222, an inert gas, and its short half-life decay products, which attach to tiny dust particles, exposes the lungs to alpha radiation (principally from polonium-218 and polonium-

214). The exposures involved may be large for persons who have tailings in or around their houses, or who live very close to tailings. Additional, but smaller, exposures to alpha radiation may result from long-lived radon-222 decay products (principally lead-210 and polonium-210). Exposure due to radon from tailings in or around buildings is best estimated from direct measurements of its decay products in indoor air.

• *Dispersal of radon and of small particles of tailings material in air.* Radon emitted from tailings is widely dispersed in air, and exposes both nearby residents and those at greater distances. These doses are predominantly to the lungs. Wind erosion of unstabilized tailings creates local airborne tailings material. The predominant dose from airborne tailings is to the bones from eating foods contaminated by thorium-230, radium-226, and lead-210, and is small. Exposure due to airborne transport of radon and particulates from tailings usually can be directly measured only near the pile or impoundment, but may be reliably estimated for larger distances using meteorological transport models.

• *Direct exposure to gamma radiation.* Many of the radioactive decay products in tailings produce gamma radiation. The most important are lead-214, bismuth-214, and thallium-210. Hazards from gamma radiation are limited to persons in the immediate vicinity of tailings piles or removed tailings. Exposure due to gamma radiation from tailings is readily estimated from direct measurements.

• *Waterborne transport of radioactive and toxic material.* Dispersal of unstabilized tailings by wind or water, or leaching, can carry radioactive and other toxic materials to surface or ground water. Current levels of contamination appear to be low at most sites. However, contamination of surface and ground water and consequent intake by animals has been identified at three locations.

Potential exposure due to this possibility of ground and surface water contamination is highly site-specific and can generally only be determined by a careful survey program.

Our assessments of risks from tailings deal primarily with risks to man. This is because risks to other elements of the biosphere are judged to be much less significant, and would therefore be controlled to acceptable levels by measures adequate to protect man. In addition, the following discussion focuses largely on *current* levels of risk to man from tailings through air and water pathways. However, these current risks could be expanded by future misuse of tailings by man and by uncontrolled future effects of natural forces. Our disposal standards reflect consideration of both current and potential future risks from tailings.

1. Air Pathways

We estimated the hazards posed by emissions to air from tailings piles or impoundments and from tailings used in and around houses. For the first case we used standard meteorological transport models and considered exposure of people in the immediate neighborhood of the existing tailings sites, the population in local regions, and the remainder of the national population. For the second, we drew largely upon experience from houses contaminated by tailings in Grand Junction, Colorado. Four sources of exposure were considered: inhaled short-lived radon decay products, gamma radiation, long-lived radon decay products, and airborne tailings particulates.

From this analysis we conclude:

(a) Lung cancer caused by the short-lived decay products of radon is the dominant radiation hazard from tailings. Estimated effects of gamma radiation, of long-lived radon decay products, and of airborne tailings particulates are relatively less significant, although high gamma radiation doses may sometimes occur.

(b) Individuals who have tailings in or around their houses often have large exposures to indoor radon and hence high risks of lung cancer. For example, in 50 percent of a sample of 190 houses with tailings in Grand Junction, Colorado, we estimate that the excess lifetime risk to occupants due to exposure to short-lived radon decay products prior to remediation may have been greater than 4 chances in 100.

(c) Individuals living near an uncontrolled tailings pile or impoundment are also subject to high risks from short-lived radon decay products of radon emitted directly from tailings. For example, we estimate that people living continuously next to some tailings sites can have incremental lifetime lung cancer risks as high as 2 chances in 100.

(d) Based on models for the cumulative risk to all exposed populations, we estimate that, without control, the radon released directly from all tailings currently in existence at presently (1983) licensed sites would cause about 500 lung cancer deaths per century. This figure does not account for any deaths from misuse or windblown tailings because their number is more difficult to predict, even though risk to individuals from such tailings may be somewhat greater than from direct radon emissions. By the year 2000, we estimate that, without control, the amount of tailings existing then would cause approximately 600 lung cancer deaths per century. Approximately one-half of these deaths are projected to occur less than 50 miles from the piles. This increase is small, due primarily to the large amount of unused capacity at present sites, so that most new tailings could be placed on top of existing tailings. This analysis assumes that this will be the actual case, although it is possible that ground water contamination problems would be severe enough to require some piles to be closed. If this is the case, this estimate would be increased.

There is substantial uncertainty in these estimates because of uncertainties in the rate of release of radon from tailings sites, the exposure people will receiwe from its decay products, and from incomplete knowledge of the effects on people of these exposures. The values presented here represent best estimates based on current knowledge. In addition, these estimates are based upon current sizes and geographical distributions of populations and estimated production of tailings to the year 2000. As populations continue to increase in the future, and as production continues beyond the year 2000, the estimated impact will be larger.

Many commenters addressed the need to prevent misuse. Most concluded that misuse was the most hazardous aspect of tailings and should receive foremost attention. Although most concluded that misuse should be discouraged through means of passive controls, some concluded that misuse could be adequately controlled by institutional means. We conclude that a primary objective of standards for control of hazards from tailings through air pathways should be isolation and stabilization to prevent their misuse by man and dispersal by natural forces, such as wind, rain, and flood waters. A second objective is to minimize radon emissions from tailings sites. A third objective is the elimination of significant exposure to gamma radiation from tailings.

2. Water Pathways

Water contamination does not now appear to be a significant source of radiation exposure at most sites. However, in addition to radionuclides, nonradioactive toxic substances, such as arsenic, molybdenum, and selenium, can be leached from tailings and contaminate water. Such contamination could affect crops, animals, and people. Process water is used to carry tailings to the piles or impoundments as a slurry. Rainwater also may collect on the tailings. The greatest threat of contamination ap-

pears to be from process water discharged with the tailings from the mill, although, in principle, it could be from the gradual effects of rainwater over the indefinite future. Most of this water eventually evaporates or seeps away. Elevated concentrations of toxic or radioactive substances in groundwater have been observed at many active sites (seven are identified in the FEIS), and in some standing surface water ponds (but only rarely in surface running water). Any future contamination of water after disposal would arise from the effects of rain or through flooding, from penetration of tailings from below by ground water, or from leaching of tailings transported offsite.

A theoretical analysis performed for the NRC of a large model tailings impoundment with no seepage control showed that contamination of ground water by selenium, sulfate, manganese, and iron might exceed current drinking water standards over an area 2 kilometers wide and 8 to 30 kilometers long. More than 95 percent of this projected contamination was attributed to initial seepage of process water discharged with the tailings during mill operations.

We recognize that the NRC generic model is only one of several that could be applied to transport of contaminants in groundwater. Other models could predict greater or less risks of ground water contamination. An example of greater risk is a plume of contamination that, under certain circumstances, could still move cohesively towards a water supply after the flow of liquid through the tailings has stopped following closure of a pile.

In general, the movement of contaminants through a pile and subsoil to ground water depends on a combination of complex chemical and physical properties, as well as on local precipitation and evapotranspiration rates. Chemical and physical processes can effectively remove or retard the flow of many toxic substances passing through

subsoil. However, some contaminants, such as arsenic, molybdenum, and selenium, can occur in forms that are not removed. Typically, ground water can move as slowly as a few feet per year, and only in coarse or cracked materials does the speed exceed one mile per year. For these reasons, contaminants from tailings may not affect the quality of nearby water supply wells for decades or longer after they are released. However, once contaminated, the quality of water supplies cannot usually be easily restored simply by eliminating the source (although, in some cases, removing or isolating the tailings may contribute to improving water quality).

Based on results from the NRC generic model for mill tailings, it is likely that the observed cases of ground water contamination result from seepage of the liquid waste discharges from the mill, and can be controlled by preventing this seepage until the tailings dry out by natural evaporation. Additional future contamination of ground water after these liquid wastes are dried up should be much smaller, and in most cases would be expected to be eliminated by measures required to control misuse of disposed tailings by man and dispersal by wind, rain, and flood waters. These measures should also effectively eliminate the threat of contamination of surface water by runoff or from leaching of tailings transported offsite, and provide a degree of protection of surface and ground water from contamination by flooding. However, at some sites, especially in areas of high rainfall or where ground water tables intersect the tailings, special consideration of potential future contamination of ground water may be needed in designing disposal systems. For example, some commenters suggested incorporation of the SWDA rules for impoundment caps for wet sites. Others pointed out that for new piles careful site selection would provide protection of ground water.

We conclude that the primary objective of standards for control of hazards from tailings through water path-

ways is to prevent loss of process water through seepage, prior to closure. A secondary objective is to avoid surface runoff and infiltration both before and after disposal.

C. Control of Hazards from Tailings

We consider methods for control so as to assess the achievability, economic impact, and reliability of controls to meet alternative standards. As noted above, the objectives of tailings disposal (and of tailings management prior to disposal) are to prevent misuse by man, to reduce radon emissions and gamma radiation exposure, and to avoid the contamination of land and water by preventing erosion of tailings by natural processes and seepage of waste process water. The longevity of control is particularly important. This can be affected by the degree to which control measures discourage disruption by man; and by the resistance of control measures to such natural phenomena as earthquakes, floods, and windstorms, and to chemical and mechanical processes in the piles or impoundments. ("Piles" commonly means tailings simply piled up on the ground, and "impoundments" means piles constrained by dikes made of other materials. We will use the term "piles" to mean both henceforth.) Prediction of the long-term integrity of control methods becomes less certain as the period of concern increases. Beyond several thousand years, longer-term geomorphological processes and climatic change become the dominant factors. Methods are available for projecting performance for periods up to about 1000 years. A recent report prepared for the NRC ("Design Considerations for Long-Term Stabilization of Uranium Mill Tailings Impoundments," Colorado State University, 1983) provides an up-to-date detailed review of these matters.

Methods to prevent misuse by man and disruption by natural phenomena may be divided into those whose continued integrity depends upon man and his institutions

("active" controls) and those that do not ("passive" controls). Examples of active controls are fences, warning signs, restrictions on land use, inspection and repair of semi-permanent tailings covers, temporary dikes, and drainage courses. Examples of passive controls are thick earthen covers, rock covers, massive earth and rock dikes, burial below grade, and moving tailings piles out of locations highly subject to erosion, such as unstable river banks.

Erosion of tailings by wind, rain, and flooding can be inhibited by contouring the pile and its cover, by stabilizing the surface (with rock, for example) to make it resistant to erosion, and by constructing dikes to divert rapidly moving flood waters. Erosion can be inhibited even more reliably by burying tailings in a shallow pit and/or by locating them away from particularly flood-prone or otherwise geologically unstable sites. Thus, especially in the case of new tailings piles, shallow burial and sites with favorable long-term characteristics should be given preferred consideration.

Methods to inhibit the release of radon range from applying a simple barrier (such as an earthen cover) to such ambitious treatments as embedding tailings in cement or processing them to remove radium, the precursor of radon. Covering tailings with a permeable (porous) barrier, such as compacted earth, delays radon diffusion so that most of it decays in and is therefore effectively retained by the cover. In addition to simple earthen covers, other less permeable materials such as asphalt, clay, or soil cement (usually in combination with earthen covers) could be used. The more permeable the covering material, the thicker it must be to achieve a given reduction in radon release. However, maintaining the integrity of control of radon by thin, very impermeable covers, such as plastic sheets, is unlikely, even over a period as short as several decades, given the chemical and physical stresses present at piles.

The most likely constituents of cover for disposal of tailings are locally available earthen materials. The effectiveness of an earthen cover as a barrier to radon depends most strongly on its moisture content. Typical clay soils in the uranium milling regions of the West exhibit ambient moisture contents of 9 percent to 12 percent. For nonclay soils ambient moisture contents range from 6 percent to 10 percent. The exact value depends upon the material involved, and on local climatic conditions. The following table provides an example of the changes in cover thicknesses that might be required to reduce radon emission to 20 pCi/m²s for the above ranges of soil moisture. Four examples of tailings are shown that cover the probable extreme values of radon emission from bare tailings (100 to 1000 pCi/m²s); the most common value for old tailings is approximately 500 pCi/m²s, and for new tailings is approximately 300 pCi/m²s.

ESTIMATED COVER THICKNESS * (IN METERS) TO ACHIEVE 20 pCi/m²s **

Radon emission from tailings (pCi/m²s)	Percent moisture content of cover			
	6	8	10	12
100	1.7	1.3	1.0	0.7
300	2.8	2.2	1.5	1.1
500	3.4	2.6	2.0	1.5
1000	4.1	3.2	2.4	1.8

* These values were calcuated from equation (9) in Appendix P of the Final Generic Environmental Impact Statement on Uranium Milling, U.S. Nuclear Regulatory Commission, NUREG-0706, September 1980. They do not include allowance for uncertainties in tailings moisture content or diffusion properties of the cover.

** A picocurie (pCi) is a trillionth of a curie. One picocurie of material produces just over two transformations per minute. A pCi/m²s is a unit for the release rate of radioactivity from a surface (m = meter, s = second).

These values are for homogeneous covers, and assume the tailings have the same moisture content as the cover. In practice, somewhat thicker covers would be required

to provide long-term assurance of satisfying any particular level of control. Some of the factors that must be considered for predicting long-term performance are moisture content of the tailings and cover at equilibrium, and the measured diffusion characteristics of cover materials. The DOE and NRC have conducted studies which provide a basis, at least within a limited range of control and predictability, for addressing these factors in the design of tailings covers based on locally available materials and climate.

Methods that control radon emissions will also prevent transport of particulates from the tailings pile to air or to surface water. Similarly, permeable covers sufficiently thick for effective radon control will also absorb gamma radiation effectively (although thin impermeable covers will not).

Two methods may be considered for protecting ground water at new tailings piles. The first is the placement of a physical barrier, called a liner, between the tailings and the acquifer zone, to prevent water containing hazardous constitutents from entering the aquifer. Either clay or plastic liners can be installed at about the same cost. Both have shortcomings. Plastic liners are impermeable, but may be subject to rupture through poor installation or uneven loading. Clay liners are permeable to some constituents, and may require use of additional measures, such as partial neutralization of the tailings, especially at acid leach mills, to satisfactorily protect ground water, but are expected to retain their effectiveness for long periods of time. The second method is treatment of process water to modify its acidity or alkalinity, if such treatment were shown to prevent contamination. At a neutral level many hazardous constituents of tailings liquids become insoluble and thus not available to contaminate ground water. However, not all hazardous constituents are so affected, and the action of rainwater, certain weathering processes, and mineralization of the soil or

rock matrix can upset this neutralization over time, thereby releasing contaminants. There is little difference in costs for these two methods. Liners (either clay or synthetic) are currently required by NRC as a matter of good engineering practice for most new tailings impoundments.

EPA does not believe it is environmentally desirable to require all new wastes at existing sites to be placed on new piles, because new piles would increase radon emissions, at least until the pre-existing pile is covered, and would permanently contaminate more land. Satisfying ground water standards at existing tailings sites that do not have liners, however, will require widely varying actions from site to site. Neutralization of existing tailings is not a generally feasible option since it would require excavation of most, if not all of the tailings to assure mixing, and may not immobilize all hazardous constituents. Ground water contamination is known to have occurred at seven sites, and may be occurring at many others. It may not be possible to cleanup the ground water at some sites. In the worst cases a new, lined tailings pile may be required to prevent contamination from new tailings. In other cases, existing tailings piles may release essentially no contaminants to ground water because the type of soil they rest on acts as an effective liner. We have discussed the range of possible costs for cleanup of ground water in the FEIS and RIA. In practice, we expect most tailings piles will fall somewhere between these two extremes. Less expensive corrective action than a new liner may be sufficient to satisfy ground water standards for hazardous constituents at many sites. For example, an active water management program may be employed to reduce the quantity of water in the tailings and thus reduce the driving force for ground water contamination, or back pumping of water around the piles may prevent losses to the surrounding ground environment. Actions such as these are already being taken

at certain sites (Cotter Mill, Canon City, CO, and Homestake Mill, Grants, NM, for example).

Control of possible long-term low-level contamination of ground water may sometimes be difficult. In cases where intrusion of contamination into ground or surface water is a potentially significant problem, liners and caps may provide a good degree of protection for at least many decades. However, more permanent protection may, in such cases, require choice of (for new tailings) or removal to (for existing tailings) a site with more favorable hydrological, geochemical, or meteorological characteristics.

Very effective long-term inhibition of misuse by man, as well as of releases to air and surface water, could be achieved by burying tailings in deep mined cavities. In this case, however, direct contact with ground water would be difficult to avoid. The potential hazards of tailings could also be reduced by chemically processing them to remove contaminants. Such processes have limited efficiencies, however, so the residual tailings would still require some control. Furthermore, the extracted substances (e.g., radium and thorium) would be concentrated, and would themselves require careful control.

We analyzed the practicality of a number of possible control methods. These are described in the FEIS and the RIA. The total cost of disposal by surface or shallow burial is affected most strongly by the type of material used to stabilizer [sic] the surface of the trailings [sic] against erosion and to inhibit misuse by man, and by the water protection features required. Total costs are less sensitive to the amount of cover required to inhibit radon release. In general, costs of covers using man-made materials (e.g., asphalt) are somewhat higher than costs for earthen covers, and the reliability is lower. Active control measures are usually less costly in the short term than are passive measures, but are considered much less reliable in the long term. Deep burial of

tailings piles or use of chemical processing to extract radium are much more costly than for surface or shallow burial (below grade) disposal using covers, and the practicality is not demonstrated.

D. Environmental Standards and Guidance Now Applicable to Uranium Tailings

EPA recognizes that it is establishing standards in an area that is already the subject of governmental regulation and has taken into account, where relevant, the existing schemes and levels of protection in developing these standards.

EPA promulgated 40 CFR Part 190, "Environmental Radiation Protection Standards for Uranium Fuel Cycle Operations," on January 13, 1977 (42 FR 2858). These standards specify the upper limits of radiation doses to members of the general public to which normal operations of the uranium fuel cycle must conform. They cover radiation doses due to all environmental releases of uranium by-product materials during the period a milling site is licensed, with the exception of emissions of radon gas and its decay products.

The Nuclear Regulatory Commission promulgated rules in 10 CFR Part 40 on October 3, 1980, which specify licensing requirements for uranium and thorium milling activities, including trailings [sic] and wastes generated from these activities (45 FR 65521). These rules specify technical, surety, ownership, and long-term care criteria for the management and final disposition of by-product materials. Some of these rules are affected by these standards. For example, they specified a design objective of 2 pCi/M^2s and a longevity of greater than 1000 years for disposal of tailings. Due to congressional actions, these regulations have never been enforced by NRC, although some Agreement States have enforced comparable regulations. We note that the NRC regulations specified design

objectives; that is, the values specified were to be achieved based on average performance; whereas these EPA rules specify standards, which designers must plan not to exceed, with a reasonable degree of assurance. The NRC has noted that any changes necessary will be made when these EPA standards are promulgated, and has already suspended those portions of its regulations which are affected by these standards (48 FR 35350; August 4, 1983).

Under the Agreement State program, States can issue licenses for uranium processing activities, including control and disposal of by-product materials. The NRC has enumerated in 10 CFR Part 150 the authorities reserved to it in its relations with Agreement States under the provisions of UMTRCA, and has specified conditions under which Agreement States may issue licenses under UMTRCA (45 FR 65521). NRC's conditions include the specification that State licenses must ensure compliance with EPA's standards. Some Agreement States can adopt more stringent rules than those adopted and enforced by the NRC, including requirements that are more stringent than EPA's standards.

EPA promulgated 40 CFR Part 260 et seq., "Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities," under Subtitle C of the Solid Waste Disposal Act, as amended on July 26, 1982 (47 FR 32274). Although radioactive materials controlled under the Atomic Energy Act of 1954, as amended, are not covered by the SWDA, UMTRCA requires that the standards proposed herein provide for protection of human health and the environment from nonradioactive hazards in a manner consistent with applicable standards promulgated under Subtitle C of the SWDA. The Act also requires the NRC to ensure conformance to "* * * general requirements established by the Commission, with the concurrence of the Administrator, which are, to the maximum extent practicable, at

least comparable to requirements applicable to the possession, transfer, and disposal of similar hazardous material under [Subtitle C of SWDA]."

EPA promulgated 40 CFR Part 440, "Ore Mining and Dressing Point Source Category; Effluent Limitations Guidelines and New Source Performance Standards, Subpart C—Uranium, Radium and Vanadium Ores Subcategory," on December 3, 1983 (47 FR 54598). The purpose of 40 CFR Part 440 is to establish effluent limitations and standards under the Clean Water Act for existing and new sources in a number of ore mining and dressing subcategories. Out of 27 mills in the uranium, radium and vanadium ores subcategory existing at that time, only one was discharging directly to surface water. In view of this, the regulations did not establish best available technology (BAT) limitations for existing sources in this subcategory. The one uranium mill directly discharging effluents is currently regulated by a discharge permit in accordance with previously existing best practicable control technology (BPT) effluent limitations contained in 40 CFR Part 440. The new source performance standards (40 CFR 440.34(b)) were based upon the demonstration of no discharge to surface waters at the 26 other mills. These standards apply to locations where the annual evapotranspiration rate exceeds the annual precipitation rate (as is the case in most uranium milling areas), and require no discharge of process waste water to surface waters from mills using the acid leach, alkaline leach, or combined acid and alkaline leach process for the extraction of uranium. For locations where there is more precipitation than evapotranspiration process waste water can be discharged up to the difference between annual precipitation and evapotranspiration.

Solution extraction, or "*in situ*" mining, is a processing method in which uranium is recovered from ore without moving or disturbing the ore body. In this method holes are drilled at selected points around an ore body

and a solvent is pumped into some holes and the resulting solution out other holes. The solvent passes through the ore, dissolves the uranium, and carries it back to the surface. The uranium is then stripped from the solution and concentrated. The solvent, which is stored in holding ponds, can be treated and reused or discarded. Although this method produces no sandy tailings, it does produce sludges that contain many of the same radioactive and nonradioactive substances found in tailings piles. Consequently, the above-ground wastes from *in situ* mining are covered in these proposed standards. We note that because *in situ* mining and conventional milling currently are done in the same regions of the country, disposal of sludges on tailings piles may often be arranged.

Rules for protection of ground water from the underground operations of *in situ* mining are provided by the Underground Injection Control program promulgated under Sections 1421 and 1422 of the Safe Drinking Water Act. The associated regulations, 40 CFR Parts 144, 145, and 146, impose administrative and technical requirements on such operations, through either approved State programs or EPA-implemented programs. These regulations are not intended to apply to the underground ore bodies depleted by *in situ* uranium mining operations.

In addition to these rules established under UMTRCA, EPA is required to establish emission standards under the Clean Air Act (CAA) for hazardous air pollutants. Although there are no final standards for air emissions applicable to mill tailings piles, a proposed rule for radionuclides has been published in the Federal Register (48 FR 15076) on April 6, 1983. The relationship of the Clean Air Act of this rule is discussed in more detail alter in this preamble.

Finally, radiation protection guidance to Federal agencies for the conduct of their radiation protection activi-

ties was issued by the President on May 13, 1960 and published on May 18, 1960 (25 FR 4402). Federal Radiation Protection Guidance governs the regulation of radioactive materials by the NRC and Agreement States, and includes the following guidance: "* * * every effort should be made to encourage the maintenance of radiation doses as far below [the Federal Radiation Protection Guides] as practicable * * *" and "There can be no single permissible or acceptable level of exposure without regard to the reason for permitting the exposure. It should be general practice to reduce exposure to radiation, and positive effort should be carried out to fulfill the sense of [this Guidance]. It is basic that exposure to radiation should result from a real determination of its necessity." This guidance is currently known as the "as low as reasonably achievable" (ALARA) principle. It is particularly suited to minimizing radiation exposure under conditions that vary greatly from site to site, or from time to time, and is an integral part of NRC and Agreement State licensing determinations.

The standards published here will supplement the above standards, guidance, and regulations in order to satisfy the purposes of UMTRCA to "* * * stabilize and control * * * tailings in a safe and environmentally sound manner and to minimize or eliminate radiation health hazards to the public." UMTRCA does not provide specific criteria to be used in determining that these purposes have been satisfied. EPA's objective, when not preempted by other statutory requirements, has been to propose standards that: (1) Take account of health, safety, and environmental and economic costs and benefits in a way that assures adequate protection of the public health, safety, and the environment; (2) can be implemented using presently available techniques and measuring instruments; and (3) are reasonable in terms of overall costs and benefits.

The legislative record shows that Congress intended that EPA set general standards and not specify any particular method of control. "The EPA standards and criteria should not interject any detailed or site-specific requirements for management, technology or engineering methods * * *" (H.R. Rep. No. 1480, 95th Cong., 2d Sess., Pt. I, P.17.) UMTRCA gives the NRC and the Agreement States the responsibility to decide what methods will assure these standards are satisfied at specific sites. (However, EPA must concur with NRC regulations established to implement Section 82a(3) of UMTRCA.) Therefore, our analyses of risk, control methods, costs, and other pertinent factors emphasize the general characteristics of uranium mill tailings and the affected sites.

IV. Resolution of Major Issues Raised in Public Comments

A. The Basis for the Standards

1. Health Risk Models

Several commenters expressed the view that the models used by EPA overestimate health risks from breathing radon decay products. Others believe EPA underestimated the risk. For example, the American Mining Congress (AMC) stated that "EPA has systematically overestimated the factors which determine potential health effects from mill tailings. In the aggregate, these overestimates combine to yield an overestimate factor of about 60." These alleged factors are:

Area of model tailings piles	1.4
Radon flux per unit activity	1.8
Transport and dispersion models	5.0
Equilibrium for radon decay products	1.7
Risk of lung cancer	3.0
Population near tailings piles	Unknown

The total radon emitted from tailings is approximately proportional to the surface area covered by tailings. EPA used the same area that NRC used in its FGEIS,

80 hectares, to estimate radon emissions. The AMC prefers 50 hectares, and points out that NRC (in NUREG-0757, Feb. 1981) later revised its estimate to 50 hectares. However, current projections of uranium production indicate that very few new mills or piles, if any, will start up between now and the late 1990's. Thus, unless a significant number of existing piles are unable to comply with the requirements of this rule regarding ground water protection, essentially all radon emissions will be from existing piles, which have an average area of about 70 hectares, as shown in the FEIS. In addition, radon may be emitted from on-site areas contaminated by wind-blown tailings. We conclude the area of piles has been overestimated at most by a factor of 1.16.

The emission rate of radon per unit area of tailings is directly related to the activity of radium-226 in tailings. Several factors which are not well understood influence this emission rate. In the report cited above, the NRC concluded: "Considering the variation observed under differing conditions at a number of sites, the staff has elected to apply conservative specific flux values of 0.3 [pCi of radon-222 per square meter-second/pCi of radium-226 per gram of tailings] for wet tailings and 1.0 for dry tailings and to count most tailings as dry in making the calculations." EPA agrees with this conclusion and believes no correction which assumes that some tailings are permanently wet is appropriate for this factor.

Regarding transport models, measurements are consistent with the transport and dispersion models we used. This is discussed in detail in the FEIS. The method used by EPA has been the basic work-horse of local dispersion estimation for years. In 1977, the participants of an expert group assessing atmospheric transport of radionuclides concluded that, for distances out to 10 km in reasonably flat terrain, and given good local wind observations: "Accuracy for the usual annual average con-

centration is about a factor of ±2." Furthermore, these dispersion estimates are based on an empirical approach that is inherently unbiased and that should therefore be as likely to overpredict as to underpredict.

It should be noted that we are not modeling background concentrations of radon. While it may be experimentally difficult to demonstrate the increment above background due to a tailings pile at distances greater than 1 km, there is no reason to believe that the basic physical principle of conservation of mass does not continue to be valid. Once released to the atmosphere, radon, which is a chemically inert gas, disperses freely until it is removed by radioactive decay. We conclude that our dispersion estimates provide a reasonable basis for calculating atmospheric concentrations of radon.

There appears to be a misconception about the conditions to which EPA's assumption of a 0.7 equilibrium fraction for radon decay products applies. (The "equilibrium fraction" expresses the amount of radon decay products actually present relative to the maximum theoretically possible. This fraction is important, since the health risk is primarily due to radon decay products, not to radon itself.) Most of the data cited by commenters to support a lower equilibrium fraction are for situations in which the source of radon is diffusion into houses from underlying soil. In this situation the initial decay product equilibrium fraction is zero. For the airborne radon from tailings piles considered in EPA's estimates, the decay product equilibrium fraction in outdoor air approaches 1.0, beyond the vicinity of a pile. After taking into account periods of time an individual spends indoors and outdoors, periods of time a house is well-ventilated by outdoor air, and the fate of radon and decay products in outdoor air when it infiltrates a house, we conclude use of an average value of 0.7 for the effective equilibrium fraction for exposure of people to airborne radon from piles is appropriate for distances far from tailings

piles. This value is therefore retained for calculations of total impact of radon releases from piles. Very close to tailings piles, however, the decay product equilibrium factor in outdoor air is low. We conclude, therefore, after taking the same indoor outdoor factors into account, that an average effective decay product equilibrium fraction about one-half as large is probably more appropriate next to piles. This lower value should be applied to estimates of the maximum individual risk next to piles.

The EPA estimate of lung cancer risk from radon decay products is based on studies of uranium and other heavy metal miners, is consistent with the most recent recommendations of the NAS BEIR Committee (1980), and is within 20 percent of the value recommended for use in a recent, exhaustive study conducted in Canada for their Atomic Energy Control Board (1982). We have noted our difficulties with the assumptions which underlie other estimates cited by commenters in our detailed responses to comments in the FEIS. We conclude the EPA value should be used in the absence of any convincing evidence that another value is more appropriate.

EPA used two regional populations for its risk estimates; the first population, identified as for a "remote" site, was hypothetical, and was taken from NRC's "Final Generic Environmental Impact Statement on Uranium Milling" (FGEIS). The second population, identified as for a "rural" site, is that for the Edgemont, S.D. site, and is based on 1970 census data. We assumed that a mix of six "rural" and 17 "remote" sites would properly represent the 23 sites modeled in the DEIS. We have just received the results of a 1983 population survey for all 52 mill tailings sites performed for us by Battelle Pacific Northwest Laboratories. This survey, which was limited to individuals within 5 km of the piles, shows that the total population at the 26 active sites was 2054

within 2 kilometers of all active tailings piles, and 14,737 within 5 kilometers.

We have re-evaluated the local and regional health risk based upon this resurvey of current populations within 5 km and 1970 census results for populations from 5 to 80 km of the 26 active sites. The re-evaluation show [sic] a small decrease in calculated local effects, and an increase of equal size in calculated regional effects. (Our estimates of risk to more distant populations, i.e., to the remainder of the United States, are unaffected.) These data indicate that our initial estimate of total health effects to populations is correct. (We note that we have assumed that there will be no increases of populations at these sites over the next 1000 years, a clearly nonconservative assumption.)

In summary, we do not believe the total health effects in the DEIS have been overestimated. The factor of about 1.16 due to a slightly different average pile area is likely to be negated by normal population increases (not accounted for in our estimates) within the first few decades of the lifetime of the hazard posed by these tailings. The estimate of maximum individual risk for a model pile is affected principally by our assumption for the equilibrium fraction for radon daughters, and should be reduced by about a factor of two. We believe this change is insufficient to warrant changing our basic conclusions regarding the risk from tailings.

2. Significance of Risk from Radon Emitted by Tailings Piles

Several commenters argued that EPA has not demonstrated that the risks associated with radon emissions from tailings are significant, and observed that much of the health impact attributed to tailings accrues to very large numbers of people at very low levels of individual disk. They suggested that the proper test of significance

is to compare such risks with common hazards, such as the risk from the natural background radiation. For example, they would compare the 6 lung cancers per year that EPA estimates (see FEIS) could result from uncontrolled tailings piles after the year 2000 with: the 21,000 such cancers a commenter estimated as caused annually by background radiation; deaths from motor vehicle accidents (50,000 per year) and home accidents (25,000); tornadoes (130); etc. Based on such comparisons, these commenters concluded that the risks from radon emitted from tailings are not significant, and that EPA's standard should not limit such emissions.

EPA believes these comparisons are misdirected and do not address a central purpose of the legislation that requires this rulemaking, which is to "* * * make every reasonable effort to * * * prevent or minimize radon diffusion into the environment * * * from * * * tailings." EPA recognizes that radiation background and other common hazards cause far greater total annual harm than anyone would reasonably estimate might occur from uncontrolled radon emissions from tailings. However, these other risks are not the subject of this rulemaking. Comparisons of the type suggested may be useful for setting priorities for efforts to reduce the variety of hazards to public health (to the extent that they are avoidable), but they are not useful for deciding the appropriate level of control for a specific source of hazard. That decision must be based upon the specifics peculiar to the hazard under consideration. The existence of other hazards does not, absent Congressional direction, justify EPA's delaying these standards until all other controllable hazards are addressed, or justify EPA's ignoring Congress' will that standards be set.

The fact that the health impact of tailings is in large part attributable to small radiation doses delivered to large numbers of people over long periods of time was

recognized when UMTRCA was enacted. The then Chairman of the NRC testified as follows: "The health effects of this radon production are tiny as applied to any one generation, but the sum of these exposures can be made large by counting far into the future, large enough in fact to be the dominant radiation exposure from the nuclear fuel cycle. Whether it is meaningful to attach significance to radiation exposures thousands of years in the future, or conversely, whether it is justifiable to ignore them, are questions without easy answers. The most satisfactory approach is to require every reasonable effort to dispose of tailings in a way that minimizes radon diffusion into the atmosphere." (H.R. Rep. No. 1480, 95th Cong., 2nd Sess., Pt. II, p. 25.) We have concluded that maximum individual lifetime risk (estimated as 2 in 100) and the long-term cumulative impact on populations (potentially many tens of thousands of deaths over the long term) due to radon emissions from tailings are clearly significant enough to justify controls. As discussed in the FEIS, RIA, and a later section of this Preamble, our analysis shows that tailings can, at a reasonable cost, be disposed of in a manner that provides, among other benefits, greatly reduced radon emissions.

3. Standards Based on Current Populations

During the review of the standards for the inactive sites by certain Federal agencies, questions were raised regarding the appropriateness of the control standards for general application to all 24 inactive sites. Some reviewers suggested that less restrictive standards might be appropriate for sites that are in currently sparsely-populated areas. Other reviewers suggested that we consider a radon standard that applies at and beyond the fenced boundary of such a site, i.e., a standard that relies in part on dispersion and institutional maintenance of control over access. EPA requested public comments on these issues for the inactive sites (48 FR 605,

January 5, 1983). These issues are most simply stated as: (1) Should the degree of radon control after disposal depend in part on the size of the current local population, and (2) Should implementation of the disposal standards be permitted to depend primarily or in part on maintenance of institutional control of access (e.g., by fences)? We also specifically requested comments on these issues in the April 29, 1983 notice of proposed rulemaking for active mills.

Most commenters who addressed the first of these issues opposed different standards at remote sites (although most industry comments favored less restrictive standards for *all* sites). Many raised the "equity" consideration, i.e., the fairness of protecting a few people less just because of where they live. Others commented that many of these sites are locations where people are unlikely to live, or, conversely, that the sizes of populations in the future are not predictable and cited examples of recent changes. Finally, commenters who addressed the issue of whether EPA is authorized to set different standards based on "remoteness" denied that the Agency has such authority.

In 1983 EPA counted the number of people living close to all the active and inactive mill sites. Of the 52 sites surveyed, only 7 had no people living within 5 kilometers (3 miles). Another 6 sites had 10 or fewer people living within 5 kilometers. Collectively, however, the mill sites have a normally distributed continuous range of local populations, and it is not possible to distinguish a special set of sites. The definition of a remote site is therefore difficult to achieve, unless it is done arbitrarily. In addition, demographers have concluded that it is not possible to determine that a population at a specific location will remain low in the future, if it is low now. Therefore, a choice of two different standards implies a need for institutional oversight of future population shifts and for having to upgrade the disposal at those sites that exceed

some criterion of "remoteness." Presumably, the State or Federal custodian would be responsible, not the original owner.

The motivation for considering relaxed standards at "remote" sites is to reduce the cost of disposal. Our analysis shows that any potential cost saving from less restrictive standards at such sites is not commensurate with the loss of benefits. In a later section we report the costs for several relaxed radon standards. These results show, for the case of *no* radon emission limit (case C1) and with no provision for the added costs of institutional control through fencing, land-use control, and land acquisition (to avoid unacceptably high individual doses to nearby residents), and with no provision for increased costs to meet closure requirements under SWDA (discussed below), that 46 percent of the cost of disposal at the level required by these standards (case C3) would be potentially recoverable. We have examined the added costs required for institutional control and conclude that they may vary from about 10 to 50 percent of these potentially recoverable costs, depending mostly on the cost of land acquisition at specific sites. Costs for conformance to RCRA closure requirements for a cap under § 264.228(a)(2)(iii)(E) range from about 50 to 140 percent of these potentially recoverable costs, depending upon whether or not the pile has an impermeable liner under it or not. (This SWDA requirement was excepted under the proposed standards, on the basis that it would interfere with the moisture required for radon control. This basis would no longer exist in the absence of a radon limit.) Any savings through deletion of radon control would be achieved by forgoing approximately one-half of the annual benefit (the entire impact on nonregional national populations), a considerable degree of protection against misuse, and a significant part of the anticipated total term of effective protection from all hazards, due to the greatly reduced thickness of the cover. We have con-

cluded, therefore, independent of other considerations, that when costs for institutional control and compliance with SWDA closure are added and the net saving is applied to only those sites that might be defined as "remote", the potential total cost saved is not significant enough in comparison to the benefits foregone to justify separate standards.

Finally, with regard to the Agency's legal authorization to establish a separate level of protection at remote sites by issuing two sets of standards, UMTRCA clearly contemplates that these standards be adequate for the long term and that they achieve the benefits of radon control. Regarding those objectives, we are aware of no site that is uninhabited and can also reasonably be assumed will remain uninhabited, nor are we aware of any scientific basis for concluding that there is no impact on national populations due to radon emissions from remote sites. We conclude, therefore, that relaxed standards for "remote" sites are not feasible on demographic grounds, are not defensible on legal grounds, and are not attractive, in any case, on the basis of cost-effectively achieving the various public health and environmental goals of this rulemaking.

4. Passive vs. Institutional Controls

As noted above, EPA also requested comments on whether a radon limit applied at the boundary ("fenceline") of the Government-owned property around a tailings pile, i.e., a "dispersion" standard, would be an appropriate form of standard for the sites with low nearby populations. (Such consideration could also apply to some more populated sites.) Such a dispersion standard could be satisfied largely by institutional methods, i.e., by acquiring and maintaining control over land. The proposed disposal standard, by comparison, would require generally more costly physical methods (such as applying thick earthen covers) that directly control the tail-

ings and their emissions with minimal reliance on institutional methods (i.e., it is a "control" standard). EPA also requested comments on the adequacy of such a radon "fenceline" standard to meet the objectives of the UMTRCA.

Comments on this issue ranged from strong support of primary reliance on passive stabilization for periods greater than 1,000 years to protection for only a few decades with primary reliance on institutional controls. A majority of commenters recommended retaining primary reliance on passive control rather than on institutional control. Those that favored use of institutional control (principally of misuse and maximum individual exposure) argued for limiting public access through use of fences and administrative control of land use. Those opposed cited the lack of reliability of such control, especially through use of fences in remote areas of the western United States.

EPA considers that protection from the long-term hazards associated with radioactive waste should primarily rely on passive control methods. We note, in this regard, the intent of Congress as stated in the congressional report accompanying UMTRCA: "The committee believes that uranium mill tailings should be treated in accordance with the substantial hazard they will present until long after existing institutions can be expected to last in their present forms." In addition, as noted in the proceeding section, the costs of land acquisition to limit maximum individual exposures can easily negate a significant fraction of potential savings through use of thinner covers. However, institutional controls can play a useful secondary role in supplementing passive controls and in assuring during the early period of disposal, that passive controls are adequate to achieve their design objectives.

Section 202 of the UMTRCA requires the Federal Government or the States to acquire and retain control of these tailings disposal sites under licenses. The licensor

is authorized to require performance of any maintenance, monitoring, and emergency measures that are needed to protect public health and safety. We believe that these institutional provisions are essential to support any project whose objective is as long-term as are these disposal operations, and for which we have as little experience. This does not mean we believe that primary reliance should be placed on institutional controls; rather, that institutional oversight is an essential backup to passive control. For example, as long as the Federal Government or the States exercise their ownership rights and other authorities regarding these sites, they should not be inappropriately used by people. In this regard, even with the disposal actions required by these standards it would not be safe to build habitable structures on the disposal sites. Federal or State ownership of the sites is assumed to preclude such inappropriate uses.

5. Control of Radon Releases During Milling Operations

The proposed rule anticipated that the regulatory agency apply the "as low as reasonably achievable" (ALARA) principle of Federal Radiation Protection Guidance in establishing management procedures and regulations to control radon from operating mills. This approach was proposed because EPA concluded that a numerical standard to control radon was inappropriate for application during operations. This is because practical methods for reducing radon emissions during operations of existing mills and piles vary in effectiveness with time; it is very difficult to measure, quantitatively, their efficacy; and different methods are appropriate for different sites. The primary means for controlling radon emissions from existing tailing piles during operations are to keep the tailings as wet as possible or to use phased disposal.

Some commenters indicated that the provisions of the proposed rule were inadequate to assure that the public

would be protected. They argued that EPA has the responsibility under both UMTRCA and the Clean Air Act to provide suitable health protection to all members of the public. They suggested that requiring certain work practices or tailings management practices would provide greater public health protection than the prov. ions of the proposed rule. For example, they note that "staged" or "phased" disposal of tailings and good water management practices could be effective and reasonable.

EPA will consider further the feasibility and practicality of providing greater assurance that radon releases will be minimize during milling operations than would the proposed rule. The Agency has not sufficiently analyzed work practice and tailings management techniques to determine whether they are suitable for this purpose and which alternatives are best. Therefore, the Agency will publish an Advance Notice of Proposed Rulemaking under the Clean Air Act for consideration of the control of radon emission from uranium tailings piles during the operational period of a uranium mill. The ANPR will enable the Agency to gather information on the feasibility, effectiveness, and cost of various alternatives that would control radon releases from operating mills. This will enable EPA to be better informed when judging whether standards are needed, and, if so, the most suitable requirements.

B. Disposal Standards

1. Design Requirements for Long-Term Protection

Comments on this issue were greatly divergent. Some commenters believed controls should be required to last for thousands of years while others thought a few decades would be adequate. Comments from experts in the fields of civil engineering and geomorphology were useful in resolving this issue.

Standard design practice for structures that, should they fail, could lead to loss of life or significant destruc-

tion of property is based on the likelihood that a sufficiently disruptive event (e.g., a flood or hurricane) might occur within a specified time. For example, a bridge may be designed to withstand all disruptive events that have more than 1 chance in 100 of occurring within, say, 50 years.

Commenters noted that rushing water caused by very high rainfall events might damage or destroy a tailings containment system that lies in its path (floods that merely cover or wet a pile are not as significant). Therefore, they suggested, the disposal method should be designed to withstand any such rainfall events that have more than a small likelihood of occurring during the period for which control is to be "reasonably assured." Expert commenters noted that floods of greater magnitude than a "1000-year flood," for example, as they are generally defined, have a high likelihood of occurring within 1000 years. Thus, in order to provide reasonable assurance that a pile will withstand all floods that have more than some small chance of occurring within 1000 years, the control system must be designed to withstand much rarer events, such as a "probable maximum flood." In practice, they suggested, adequately protecting piles for even a few hundred years requires designing control systems to withstand all events that are likely to occur within thousands of years. Furthermore, the maximum rainfall that might be expected to occur within thousands of years is very nearly the maximum possible rainfall. Therefore, in practice, the system would have to be designed for approximately the same (i.e., maximum) rainfall whether the control period is 200 years or 1000 years.

As discussed above, we believe protection for only a short period (a few decades) is inconsistent with the intent of Congress. Some commenters argued for periods longer than 1000 years. We believe that the specification of a design period of 1000 years will achieve the objectives of these commenters, while at the same time giving

engineers who must carry out these standards a design criterion reasonable to assess. We note that commenters did not identify any specific design features that would flow from a greater than 1000-year criterion that would not already be required to satisfy a 1000-year requirement.

Based on these considerations we conclude that the time over which protection should be provided should be specified as proposed.

A closely related matter is the degree of assurance with which controls can be designed to meet the longevity requirement. Some failure modes can be well quantified (e.g., performance of dikes, etc.) and others may not be as well characterized (e.g., aging characteristics of rock used to stabilize slopes). We recognize that, in some cases, it may therefore be difficult to certify conformance in all respects to a 1000-year requirement for longevity of control. For this reason we have retained the flexibility of the proposed rule to certify for shorter periods (but in no case less than 200 years). We leave the matter of fully defining what constitutes "reasonable assurance" to the implementing governmental agencies, but expect that standard engineering (design) criteria will be used to limit the probability of failure over the required longevity period to a value consistent with other design situations where public health and safety are important concerns.

2. Radon Emission Limit

Quantitative estimates of health effects from tailings can reasonably be made for radon emissions and windblown particulates. Health effects from misuse of tailings and water contamination cannot be quantified because of the extremely high degree of uncertainty associated with the likelihood and extent to which misuse and contamination might occur and the consequent degree to which people will consequently be exposed to radiation and toxic substances. (For example, tailings used as fill in unoccupied

areas would not result in direct human exposure. Using tailings as fill for residential buildings carries a high probability of very significantly elevating raidation exposure and risk. The degree to which people might be exposed to contaminants from tailings through waterborne pathways is subject to similarly high uncertainties.)

The likelihood of health effects from exposure to radon and its decay products is, considerably greater than from particulates, even when external radiation and food chain contributions are included in the estimates for particulates. Therefore, the only quantitative estimates of effects discussed are those for radon emissions. We believe, however, that effects from misuse or water contamination could be comparable to those from radon emissions if long-term protection is not afforded.

The primary concern of commenters who thought the proposed radon emission standard was too lax was the risk to nearby individuals. The estimated added lifetime risk of fatal lung cancer for someone living 600 meters from the center of a model pile is 1 in 1000 due to radon from a tailings pile emitting radon at the level of 20 pCi/m^2s, if the cover is designed to just achieve that emission level without employing additional control to provide reasonable assurance of achieving it for 1000 years.

Commenters who thought the proposed radon emission standard is too strict contended that the cost of compliance would be too high, in view of the small contribution radon from tailings makes to a population's total exposure to atmospheric radon. They also generally believed EPA had overestimated the health effects from radon. We have addressed this last concern in an earlier section of this notice.

Selecting a limit for radon emission from tailings involves four public health objectives, in addition to reducing health effects from radon released directly from the

pile. These may all be achieved by using a thick earthen cover, which serves to inhibit misuse of tailings, to stabilize tailings against erosion and contamination of land and water, to minimize gamma exposure, and to avoid contamination of ground water from tailings. A radon emission limit of 20 pCi/m^{2}s or less would require use of a sufficiently thick earthen cover to achieve all of these objectives. A limit of 60 pCi/m^{2}s or greater could be satisfied in many cases by a cover too thin to effectively inhibit misuse. Such a cover would also permit higher individual risks (up to 3 in 10^3) and would leave 20 percent of the potential health impact on populations uncontrolled. Our analysis shows that a limit of 20 pCi/m^{2}s is also cost-effective for eliminating most (95%) health effects in regional and national populations from radon released directly from the pile. Such a limit would also reduce maximum individual risks to residents near tailings piles to less than one in 1000. We concluded that levels higher than 20 pCi/m^{2}s are not justified, based on the cost-effectiveness of reduction of cancer deaths in populations, the high maximum individual risks involved at higher levels, and the likelihood that control to a level of 20 pCi/m^{2}s is reasonably achievable.

The risk to people who live permanently very close to tailings piles can still be relatively high, up to 1 in 1000 for limetime residency, for a limit of 20 pCi/m^{2}s. However, the practicability of providing more radon control by requiring design for lower levels of emission falls rapidly below 20 pCi/m^{2}s. We note that no pile has ever been protected by such a cover; that is, covers with defined levels of control and longevity are undemonstrated technology. The design of covers to meet a specific radon emission limit at these low levels must be based on measurements of properties of local covering materials and prediction of local parameters, such as soil and tailings moisture, over the long term. Because of uncertainties in measuring and predicting these parameters, the uncer-

tainty of performance of soil covers increases rapidly as the stringency of the control required increases. Thus, in the case of lower levels, the primary issue becomes whether conformance to a design standard for such levels is practicably achievable. There is some field information available regarding the practicality of reduction of radon emissions to levels approaching background. Tests conducted at a pile in Grand Junction, Colorado, showed that test plots of 3-meter thick covers made from four different earthen combinations reduced radon emissions to values ranging from 1.0+1.1 to 18.3+25.2 pCi/m^{2}s. The efficiences of these covers ranged from 88.8 percent to 99.7 percent. These results apply to the first two years after emplacement, and do not reflect performance after long-term moisture equilibrium is achieved (some moisture contents were still considerably elevated over prevailing levels). We believe results like these can generally be expected, because the radon control characteristics of earthen materials used for covers will vary from site to site. Three of the four covers studied satisfied 20 pCi/m^{2}s with a reasonable degree of certainty over the term of the test. The other cover (18.3+25.2 pCi/m^{2}s) was uncompacted and its poor performance can therefore be discounted. Exactly how much thicker these covers would need to be to reliably achieve a lower limit (e.g., 6 or 2 pCi/m^{2}s) is not known. Experts commented during hearings on the standards that, although covers can be designed to meet such levels as 20 pCi/m^{2}s, estimation models are not reliable at significantly lower emission levels.

We concluded that achieving conformance with a radon emission standard that is significantly below 20 pCi/m^{2}s (6 or 2 pCi/m^{2}s, for example) clearly would require designers to deal with unreasonably great uncertainty for this undemonstrated technology. That is particularly so because EPA is already requiring a margin of safety in calling for any control system to meet the designated

emission level with reasonable assurance over 1000 years. Given the predictive uncertainties in designing to meet this standard, EPA judged that to force an accounting for a second set of predictive uncertainties by forcing the standard to very low nominal levels would be to exceed the limits of reasonably available technology.

The risk from radon emissions diminishes rapidly with distance from the tailings pile (declining by a factor of three for each doubling of the distance beyond a few hundred meters). There currently are only about 30 individuals living so near to active piles that they might be subject to nearly maximum annual post-disposal risks. We expect that the actual number of people who might experience near maximal lifetime risk will be smaller, since they would have to maintain lifetime residence in the land area immediately adjacent to a tailings piles. In sum, we believe that the probability of a substantial number of individuals actually incurring these maximum calculated risks is small.

We conclude that it is not reasonable to reduce the emission standard below 20 pCi $m^{-2}s$ because of: (1) The uncertainty associated with the feasibility of implementing a requirement for a significantly lower standard, (2) the small increase in total health benefits associated with such thicker covers, and (3) the limited circumstances in which the maximum risk to individuals might be sustained.

As noted above, the 20 pCi $/m^2s$ mission limit was selected to meet the stated objectives of reducing the likelihood of misuse, spreading due to erosion, and control of radon emissions after a thorough evaluation of the current existing information on the technical and economic aspects of alternative levels of control. EPA recognizes the limitations inherent in this information, since no pile has yet been disposed of. Better information may well become available within the next several years as DOE pro-

ceeds with the disposal program for inactive piles. Therefore, consistent with Section 275(b)(2) of UMTRCA, EPA intends to continue to monitor these efforts over the next several years and will propose revising these standards if subsequent technical and economic information shows modifications are warranted.

The standard requires that disposal be designed to provide "reasonable assurance" that radon emissions will not exceed 20 pCi/m^{2}s (averaged over the disposal area) for 1000 years. Some commenters expressed the opinion that the meaning of this term was not clear. A key word in this requirement is "designed," since we do not intend compliance with a 1000-year requirement to be determined by monitoring. "Reasonable assurance" in the design of covers means the radon emission limit should be expected to be achieved, over the required term, with a degree of assurance commensurate with the "reasonable assurance" of longevity discussed in the preceding section. Thus, in designing the cover the uncertainties in attenuation characteristics of material used should be taken into account in a conservative manner. This will tend to increase the cover thickness required over that calculated from "best estimated" values, which would yield an approximately equal probability of achieving above or below the design level. An example of uncertainty to be considered is that in the long-term equilibrium value of moisture to be expected in the cover material (i.e., over 1000 years), even though the cover material may be sprayed with water when it is laid down and compacted, and layers of coarse materials introduced to inhibit capillary action. Such spraying and layers increase the moisture (and therefore attenuation) of the cover in the near term, but it is the long-term equilibrium moisture content which governs the performance of the cover over most of its useful life. Other factors include uncertainty in measured diffusion characteristics of the particular earthen materials used (for given moisture content), and in the long-term equilibrium moisture content of the tailings themselves.

In summary, we intend that the design requirement for "reasonable assurance" should lead to thick durable covers that have a substantial likelihood of maintaining radon emissions below the 20 pCi/m^2s limit for 1000 years.

A related matter is implementation of the specification that the standard for radon emission applies to the "average" value of the release rate. This averaging is to be carried out in two ways. First, it applies over the spatial extent of any disposal area. Thus, anticipated variations due to different concentrations of radium in different parts of the pile, or minor cracks or the effects of burrowing animals and plant roots are to be averaged over, since it is the net radon from the entire tailings pile that is of significance to health. Second, the averaging is specified to apply over a time period of at least one year. Thus, daily and seasonal variations in radon emission are to be averaged over, since these are also not of significance to public health. Finally, this averaging may extend over longer periods to accommodate normal fluctuations in soil moisture content due to short-term climatic variations. Thus, the lowest recorded values of soil moisture content should not be used; rather, the average values are appropriate. Such averages should not, however, extend to times as long as the normal human lifespan, since that could result in a significant alteration in the level of protection of public health. Similarly, averaging performance over the entire period of longevity of the cover is not within the meaning of the standard.

3. Relationship to the Clean Air Act Emission Standard Requirements

The Clean Air Act also requires that EPA provide public health protection from air emissions from tailings piles. Further, EPA is publishing an ANPR to consider additional control of radon emissions during the operational phase of mills. This discussion relates to the disposal phase.

The Clean Air Act requires that the Administrator establish a standard at the level which in his judgment provides an ample margin of safety to protect the public health from hazardous air pollutants. The Agency published proposed rules for radionuclides as National Emission Standards for Hazardous Air Pollutants (NESHAPS) on April 6, 1983 (48 FR 15076). The proposed rule addressed all of the sources of emissions of radionuclides that EPA had identified. The proposed rule either provided standards for various source categories or proposed not to regulate them and provided reasons for that decision.

In the proposed NESHAPS for radionuclides EPA did not propose additional standards for uranium mill tailings, because the Agency believed the EPA standards to be established under UMTRCA would provide the same degree of protection as required by Section 112 of the Clean Air Act. The Agency explained that Congress did not describe the degree of protection that provides an ample margin of safety, nor did it describe what factors the Administrator should consider in making judgments on the appropriate standard. The Agency indicated that it did not believe that it was reasonable to establish standards for nonthreshold pollutants like radionuclides at levels that preclude any possible risk. EPA concluded that it should follow an approach that would allow it to consider various factors that influence society's health and well being. Therefore, EPA chose to consider the following factors in deciding whether standards are needed and the appropriate level of such standards:

1. The radiation dose and risk for nearby individuals;

2. The cumulative radiation dose and health impacts in populations;

3. The potential for radiation emissions and risk to increase in the future;

4. The availability, practicability, and cost of control technology to reduce emissions, and

5. The effect of current standards under the Clean Air Act or other applicable authorities.

The first three factors are used to assess the likely impact of emissions on the health of individuals and large populations and to estimate the potential for significant emissions in the future. The fourth factor enables EPA to assess whether state-of-the-art control technologies are currently in use and whether there are any practical means of reducing emissions through control technology or other control strategies. The last factor allows EPA to assess whether regulations or standards that have been established to control other pollutants are also minimizing releases of radionuclides.

The dose and risk for the individuals nearest a site are often the primary considerations when evaluating the need to control emissions of radionuclides. Controlling maximum individual dose assures that people living nearest a source are not subjected to unreasonably high risk. Further, protecting individuals often provides an adequate level of protection to populations living further away from the source.

EPA believes that cumulative dose and health impacts in populations are also an important factor. The cumulative radiation dose and health impact are determined by adding together all of the individual doses and risks that everyone receives from an emission source. This factor can sometimes be more important than the maximum individual risk in deciding whether controls are needed, particularly if an extremely large population may be exposed at low levels. The aggregate dose and population impact can be of such magnitude that it would be reasonable to require a reduction in the total impact even though, if the maximum individual dose were considered alone, one might conclude that no further controls are needed. For mill tailings, although population doses and

health impacts were an important part of our consideration, doses to the most exposed individual were equally important.

In addition, EPA considers the potential for emissions and risk to increase in the future, even though the current projected maximum individual and population risks may be very low. In this case, we do not anticipate significant future increases in the size of this industry, although populations around these sites may increase, as the national population increases.

The availability and practicality of control technology are important in judging how much control of emissions to require. EPA believes that the standard should be established at a level that will, at least, require use of best available technology. Additional actions, such as forcing the use of undemonstrated technology, closure of a facility, or other extreme measures may be considered if significant emissions remain after best available technology is in place or if there are significant emissions and there is no applicable demonstrated control technology. EPA defines best available demonstrated technology as that which, in the judgment of the Administrator, is the most advanced level of controls adequately demonstrated, considering economic, energy, and environmental impacts. We concluded that requiring the use of undemonstrated technology was appropriate for mill tailings, since their emissions are significant and there is no applicable demonstrated control technology.

Finally, EPA believes it is reasonable to consider whether other EPA standards are achieving approximately the same goal as the Clean Air Act, i.e., protecting public health with an ample margin of safety. In cases where other standards are providing comparable control, EPA believes it is appropriate not to propose redundant standards under the Clean Air Act. There would be no benefits because the public health would already be protected with an ample margin of safety, but there could

be unnecessary costs associated with implementing an additional standard.

The Clean Air Act specifies that the Administrator promulgate emissions standards to protect the public health. The Administrator is also authorized to promulgate design, equipment, work practice, or operational standards, or a combination, if it is not feasible to prescribe or enforce emission standards. The Administrator can conclude that "it is not feasible" if a hazardous pollutant cannot be emitted through a conveyance or the use of the conveyance would be contrary to laws, or if measurement methodologies are not practicable due to technological or economic limitations. As noted above, we will consider the need for such standards for the operational phase of mills.

With respect to these disposal standards, EPA has concluded that design to provide reasonable assurance that the release of radon will not exceed 20 pCi $m^{-2}s^{-1}$ for a period of 1000 years is appropriate. The level of the standard was selected after considering potential impacts both on individuals and large population groups. We consider that the uncertainties involved in design to various levels and durations of control are important factors. Potential increases in the number of mill tailings piles due to future needs for uranium were also considered. In addition, the cost and socio-economic impact of the standard and other alternatives were considered. In light of all of these considerations, EPA judges it appropriate that the standard require a level of control not heretofore applied, but for which the design uncertainties that must be accommodated are within the range of practical feasibility.

It would be desirable to reduce potential maximum individual risk further. However, the uncertainties associated with attempting designs to achieve assurance of conformance to a significantly lower standard through use of thicker covers are, we believe, unreasonably great, and

would impose large and unpredictable costs. Somewhat thicker covers than bare (or average) compliance with a 20 pCi/m^{2}s standard would require will, moreover, be called for by the requirement to provide reasonable assurance of compliance. (Other types of control are even more costly and do not provide the comprehensive protection thick covers provide.) Consequently, we have concluded it would be unreasonable to impose a standard below the 20 pCi/m^{2}s required by this rule.

The Agency believes that the standards for the disposal of uranium mill tailings established in this rule provide protection of public health comparable to that which might be established under the Clean Air Act, because the considerations on which these standards are based are comparable to those the Agency uses in establishing standards under Section 112 of the Clean Air Act. However, the final determination will be made in the Section 112 rulemaking on radionuclides.

4. Radon Concentration vs. Emission Rate Limits

A radon emission rate limit was proposed as a design standard for the disposal of tailings. Some commenters suggested that we should instead establish a concentration limit for radon in air at locations where people would be exposed. They expressed the view that EPA should establish standards based on health risk alone and that a concentration limit applied where people can live is therefore more suitable.

A design limit for emissions addresses a primary goal of these standards, the placement of a thick, durable earthen cover over the tailings, because the limit relates directly to the thickness of the cover and requires direct control of radon emissions. It also is in a form which conforms to the requirements of the Clean Air Act, which specifies direct control of emissions from a source. Under the suggested air concentration limit, transport calculations would be needed to estimate emission rates for use

in determining cover thicknesses. We believe no purpose is served by introducing the uncertainty of this extra (transport) variable into the calculations for cover thickness. In addition, the thickness of the cover required to satisfy such a standard could be arbitrarily reduced (to zero in many cases) by use of fences to restrict access. Such a situation would be unsatisfactory because it would: (1) Require permanent (for 1000 years) control of access by institutional means, and (2) would not require a cover sufficient to deter misuse. In summary, if such a standard is comparable to an emission limit, it is needlessly complex, due to the introduction of transport calculations. If not, it affords less protection by permitting dispersion instead of control.

5. Cleanup Standards

Commenters expressed confusion regarding the purpose and applicability of the proposed § 192.32(b)(2). We intended this section to distinguish disposal areas for tailings piles from other land areas on disposal and/or licensed sites that are sufficiently uncontaminated by tailings as to not require application of the disposal standards of § 192.32(a). The definition of "disposal area" and the language of § 192.32(b) have been revised to clarify these objectives.

Some commenters objected to the proposed definition. On the assumption that it was a cleanup standard they argued it is not necessary to clean up land which will be converted to government ownership upon closure, since a government agency could control use of the land. Also, they argued that even if the government allowed use of the land, including residential use, "no reliable evidence exists to indicate that levels exceeding the proposed cleanup standard would necessarily convert to indoor radon daughter exposures of sufficient magnitude to constitute significant health risks."

EPA believes there are good reasons not to leave contaminated land (other than areas meeting the disposal

standards) at former milling sites. First, the contamination may spread further, and thereby necessitate cleanup of adjacent land or properties. High indoor radon levels clearly can result if houses are built on contaminated land. Second, there are significant radiation risks (identified in the FEIS and DEIS) from pathways other than inhalation of indoor radon decay products, including external (gamma) radiation and inhalation of windblown particulates. Finally, the government agency accepting ownership of contaminated land would have to impose additional control and, possibly, incur the costs to maintain such control. EPA has decided not to change the proposed levels which define on-site land that need not satisfy the standards applicable to disposal areas.

Finally, some commenters suggested that we issue standards for the cleanup of any off-site land and buildings that may contain tailings from licensed mills. There was an implication in some comments that establishing the responsibility of any party to perform remedial actions for such sites could be affected by whether or not EPA had issued cleanup standards. EPA has issued cleanup standards (40 CFR Part 192, Subpart B) for the Federal cleanup program for off-site tailings from 24 inactive processing sites that was established under Title I of UMTRCA. Sites for which a license for uranium or thorium production was in effect on or after January 1, 1978, are excluded from coverage under Title I. We note, however, that the standards (40 CFR Part 192, Subpart B) we have already issued for the Title I program would be suitable for application to off-site contamination from active mills.

6. Wet Sites vs. Dry (Arid) Sites

Several commenters from Virginia and Illinois expressed concern regarding the applicability of the standards to wet sites, i.e., locations where annual average precipitation exceeds annual average evapotranspiration.

EPA stated in the Federal Register notice accompanying the proposed standards that if uranium mining and milling is conducted in wet regions, the adequacy and appropriateness of the standards may have to be reviewed, particularly the water protection requirements. Based on this statement the commenters were concerned that EPA intended to apply less stringent standards for tailings control at wet sites.

Our remarks concerning wet sites in the preamble for the proposed standards were intended only to acknowledge that all current U.S. uranium mills are located in arid and semi-arid areas, and that we have less experience with many of the control measures needed to comply with the standards under wet than under dry conditions.

We have modified the final standards to require environmental and health protection in all regions of the United States. EPA developed the basic ground water protection provisions in these standards for national application to hazardous waste sites. The New Source Performance Standards, 40 CFR 440.34, protect surface water by prohibiting discharges from new mills except for the amount by which precipitation may exceed evapotranspiration. Any discharged water must satisfy concentration standards corresponding to use of the best available demonstrated treatment technology. We have modified our proposal to not apply the requirements of 40 CFR 264.228 that are referenced by 40 CFR 264.221 ("Design and Operating Requirements") in order to avoid the post-closure "bathtub" effect that could otherwise occur in wet locations. For mills locationed [sic] in regions of net precipitation the final standard applies 40 CFR 264.228(a)(2)(iii)(E), which requires the closure cover to be less permeable than any liner beneath the tailings so the pile will not fill with water.

We believe these and the other provisions of the final standards provide adequate protection for wet and dry areas, considering differences in both net precipitation and population density.

C. Ground Water Standards

1. Summary of the Proposed Standards

Consistent with the standards EPA issued under the SWDA for hazardous wastes (47 FR 32274-388, July 26, 1982) the standard for tailings piles has two parts: (1) A "primary" standard that requires use of a liner designed to prevent migration of hazardous substances out of the impoundment, and (2) a "secondary" ground water protection standard requiring, in effect, that any hazardous constitutents that leak from the waste not be allowed to degrade ground water. The primary standard applies to new portions of new or existing waste depositories. The secondary standard applies to new and existing portions, the point of compliance being at the edge of the waste impoundment. The specific hazardous substances and concentrations (i.e., background levels) that define noncompliance with the secondary standard at each site will be established for uranium mill tailings by NRC and Agreement States. The SWDA rules, however, permit alternate concentration limits to be established when they will not pose "* * * a substantial present or potential hazard to human health or the environment" as long as the alternate concentration limit is not exceeded. The rule also allow [sic] "hazardous constituents" to be exempted from coverage by the permit based on the same criterion. EPA determines the alternate concentration standard or exemption under the SWDA; EPA's concurrence would be required under the proposed standards for tailings.

EPA recognized in proposing these standards that UMTRCA continues the dual regulatory system for uranium fuel cycle facilities under which EPA sets health and environmental standards and NRC establishes implementing technical, engineering, and management regulations. Under the SWDA, EPA performs all such regulatory functions for chemical hazardous wastes. UMTRCA promotes uniform Federal regulation of wastes, however, by requiring NRC's regulations for

these wastes (i.e., uranium and thorium mill tailings) to be "comparable" to requirements EPA establishes for similar hazards under the SWDA.

2. The Primary Standard

The primary standard, 40 CFR 264.221, can usually be satisfied only by using liner materials (such as plastics) that can retain all wastes. Exemptions permitting use of other liner materials (such as clay) that may release water or small quantities of other substances or, in some cases, permitting no liner may be granted only if migration of hazardous constituents into the ground water or surface water would be prevented indefinitely.

Some commenters stated that no liner technology is available which would achieve the goal of the primary standard, i.e., preventing waste from entering the ground or water. They stated that synthetic liners would tear under the strains of tailings and heavy equipment, or that they could not reliably be properly installed in such large impoundments. Other commenters noted that thicker plastic liners than that have been conventional or double liners would be more successful. A number of commenters argued that clay liners may have important advantages over plastics, but questioned whether clay liners could satisfy the conditions for an exemption.

The rulemaking record does not establish that either clay or plastic liners have unequivocal advantages or disadvantages. EPA considered these technologies when it developed the SWDA liner requirement and decided to require a liner that is capable, as a matter of engineering, of preventing migration of waste into the ground and water. The fact that failures may occur did not justify establishing a less protective standard. Recognizing that such liners may sometimes fail, EPA also issued the secondary standard to limit the consequences of such failures. UMTRCA requires standards for tailings to be consistent with the standards EPA established un-

der SWDA. We have concluded that commenters did not establish that conditions at tailings impoundments are sufficiently different from conditions EPA considered in developing the SWDA standard to justify departures from that standard.

Under these standards, all new waste storage areas (whether new waste facilities or expansions of existing piles) are subject to the primary standard—the liner requirement. If new wastes are added to an existing pile, however, the pile must comply with the secondary standard—the hazardous constituent concentration standards for health and environmental protection. Whether for a new or existing pile, if the secondary standards are found not to be satisfied and subsequent corrective actions fail to achieve compliance in a reasonable time, the operator must cease depositing waste on that pile.

3. The Secondary Standard and the Complementary Roles of EPA and NRC

Commenters correctly noted that virtually all existing tailings piles have contaminated ground water beyond the edge of their impoundments. The reason is that many of these piles were constructed without liners and before NRC increased regulatory requirements in the late 1970's. NRC's recent regulatory practice has been to require remedial actions on a cost/benefit basis when underground contaminant plumes threaten to degrade or have already degraded the potential usefulnss of offsite water.

Many commenters, including NRC, argued that the existing practices for tailings piles sufficiently protect health and the environment. They noted that under the proposed standard virtually all existing mill operations would have to either request exemptions and alternate standards and/or begin remedial actions. Commenters stated that regulating by exceptions is inappropriate.

NRC and others further argued that an EPA concurrence role for exemptions and alternative standards that would be invoked at virtually all existing mills was inconsistent with UMTRCA's foreclosure of any EPA permitting for tailings under UMTRCA or SWDA.

We have made modifications of the rule to both improve its administration and clarify its objectives.

EPA considered a wide range of alternatives before adopting the secondary standard, including a policy similar to NRC's. When EPA issued the SWDA rules, it recognized that many existing hazardous waste sites had operated for many years without liners and would not immediately satisfy the secondary standard. EPA created the opportunity for exemptions and alternative concentration standards to avoid remedial actions where such exceptions would "not pose a substantial present or potential hazard." In establishing such exemptions or alternative standards, the SWDA rules require EPA to consider specified fate-related and health and environment-related factors (see 40 CFR 264.93(b) and 264.94 (b)). "Fate" refers to the destiny of contaminants released from the waste under site-specific hydrogeochemical conditions.

EPA agrees that administrative burdens related to the dual regulatory system under UMTRCA should be minimized. We have concluded that it is appropriate under UMTRCA that the regulatory agencies (NRC and Agreement States) perform or approve analyses of fate, because this involves primarily technical and site-specific judgments. EPA does not believe, however, that it can or should delegate its responsibility for setting health and environmental protection standards. This was the reason for proposing to require EPA's concurrence with exemptions and alternative concentration standards recommended by regulatory agencies for site-specific licenses. Therefore, in determining situations requiring

concurrence, EPA will consider the health and environment-related factors in §§ 264.93(b) and 264.94(b).

Administrative burdens can be further reduced by permitting the regulatory agency to exercise discretion, pursuant to the requirements of 40 CFR 264.94(b), for establishing alternate concentration limits, as long as any contamination permitted will remain close to the pile and is within the boundaries of the licensed site. Such situations can be identified solely through analysis of fate, and we have decided not to require concurrence in such cases. This avoids the dual administrative process for alternative concentration standards under conditions where they certainly would be requested and granted. We believe this is appropriate. The contamination would be very limited in extent and concentration, can be expected to eventually dissipate after the site is closed in accordance with our closure standard, and these sites will be under effective government jurisdiction during this period. We have chosen 500 meters as the maximum distance for the purpose of this section of the rule, because it limits contamination to a small area, and, considering the size of disposal areas, will provide an adequate margin of distance to implement corrective action programs if they are required to prevent offsite contamination.

The revised standard for existing piles should be implemented in a manner consistent with the following scenario. Monitoring wells should be established at the edge of the tailings at the compliance point. This monitoring location is unique in providing the earliest practical notice of contaminants migrating from the impoundment. The regulatory agency should determine through further monitoring and fate analysis whether hazardous constituent levels now and in the future will satisfy the secondary standard within 500 meters or any closer site boundary, what corrective actions are appropriate to correct any on-site contamination, and, if some contamination is found to be not practicable to eliminate, the alter-

nate concentration limit at the edge of the tailings to indicate the minimum practicable on-site contamination. If environmental contamination is a realistic possibility (or fact) beyond 500 meters (or the site boundary), remedial actions must be taken, or alternative concentration standards (with EPA concurrence) are required.

Unlike EPA's role in SWDA, EPA's role for controlling hazardous materials from uranium tailings under UMTRCA is limited to setting standards and does not include an implementing responsibility. That responsibility is vested in the NRC and the States as the licensing agencies under Title II of UMTRCA (Section 84a(3)) and will be carried out through regulations set by the NRC, with the concurrence of the Administrator, upon promulgation of these standards by EPA.

Many of the factors that must be considered by NRC in carrying out its responsibilities for enforcing EPA's standards are discussed in the pertinent section of the notice proposing these standards (48 FR 19522-5). For convenience, we repeat here the listing of sections of the SWDA's regulations which relate to the separate EPA and NRC responsibilities. EPA's responsibilities to establish standards under Section 206 of UMTRCA are carried out through adoption of all or part of the following sections of the SWDA regulations:

i. Subpart F:

40 CFR 264.92 Ground water protection standard

40 CFR 264.93 Hazardous constituents

40 CFR 264.94 Concentration limits

(These three sections are modified and adopted as § 192.32(a)(2))

40 CFR 264.100 Corrective action program

(This section is modified and adopted as § 192.33)

ii. Subpart G:

40 CFR 264.111 Closure performance standard

(This section is adopted as part of § 192.32(b)(1))

iii. Subpart K:

40 CFR 264.221 Design and operating requirements for surface impoundments

(This section is modified and adopted as § 192.32(a)(1))

NRC's responsibilities under UMTRCA are to implement EPA's standards and to "* * * insure that the management of any byproduct material * * * is carried out in such a manner as * * * conforms to general requirements established by the Commission, with the concurrence of the Administrator, which are, to the maximum extent practicable, at least comparable to requirements applicable to the possession, transfer, and disposal of similar hazardous material regulated by the Administrator under the SWDA, as amended." EPA will insure that NRC's regulations satisfy these admonitions through its concurrence role. Relevant SWDA regulations are those embedded in Subparts A (except Section 264.3), B, C, D, E, F, G, H, and K. Examples of areas which NRC must adress in discharging these responsibilities involve functions under the six sections listed immediately above which are incorporated into these EPA standards, and the following sections of the SWDA regulations:

i. Subpart F:

40 CFR 264.91 Required programs

40 CFR 264.95 Point of compliance

40 CFR 264.96 Compliance period

40 CFR 264.97 General ground water monitoring requirements

40 CFR 264.98 Detection monitoring program

40 CFR 264.99 Compliance monitoring program

ii. Subpart G:

40 CFR 264.117 Post-closure care and use of property

iii. Subpart K:

40 CFR 264.226 Monitoring and inspection (of impoundment liners), as applicable

40 CFR 264.228 Closure and postclosure care, as applicable.

There are several of these SWDA regulations that specify monitoring after closure of an impoundment. Monitoring is a compliance activity conducted to assure that health and environmental standards are being met. The regulatory agency is responsible for establishing such requirements, including post-closure monitoring consistent with the SWDA regulations. The period over which post-closure monitoring is normally required under SWDA is 30 years. The regulatory agency should recognize, however, that monitoring of ground water for shorter or longer periods may be needed for the specific sites where tailings are located and, when appropriate, change this requirement.

A difficult consideration regarding the closure of a tailings impoundment is deciding when disposal must take place. Several factors must be evaluated in this regard, including: (1) The likelihood that a mill will resume operations; (2) the specific condition of the tailings impoundment, such as the fraction of design life remaining, and environmental contamination problems, such as windblown tailings and the likelihood that significant quantities of tailings might be spread by flooding; and (3) the cost of maintaining releases from the inactive pile in conformance with the regulations which apply to operating mills prior to disposal (including maintaining radon emissions at ALARA levels). Evaluating these factors may be difficult and complex. However, although an adequate drying-out period makes possible long-term isolation of the tailings and stabilization

of the piles, radon emissions will be greater during this period than before or after disposal. For this reason the regulatory agency should require, once a pile is allowed to begin to dry out, that disposal proceeds in an expeditious fashion, and that new liquids are not introduced to the pile so that a new drying-out period will be incurred.

The period required for the tailings to dry out is highly dependent on local meteorology. This precludes establishing a single fixed time for disposal of the tailings. We have concluded that the regulatory agency should exercise the responsibility of determining when disposal should occur, by site-specifically judging the advantages and detriments associated with all pertinent factors. This responsibility is governed by the need to conform to regulations established to satisfy the SWDA, by 40 CFR Part 190, and by the ALARA requirement on radon emissions.

NRC's closure regulations must be comparable, to the maximum extent practicable, to requirements under the SWDA, wherein short closure periods (90 and 180 days) are specified. Drying out of piles will take much longer. However, disposal should occur promptly when piles are allowed to dry out. In addition, some of the older mill sites already contain essentially completed (filled) tailings piles. The regulatory agency should promptly identify and require disposal of such tailings.

EPA and NRC are coordinating their efforts to insure health and environmental protection from uranium byproduct materials. In particular, we are working closely with the NRC to assure that NRC's general requirements for ground water protection will be comparable, to the maximum extent practicable, to EPA's requirements under the SWDA for similar hazardous materials.

4. Timing of Corrective Actions

The proposed standard requires corrective actions for ground water to be initiated within one year after a noncompliance determination is made. Commenters expressed

concern that it may take longer than one year to devise and implement an effective corrective action, for both technical and administrative reasons. Based on these considerations, EPA has revised the time limit for implementation of corrective actions to eighteen (18) months. We also note that § 264.99 of SWDA regulations require submission of corrective action plan within 180 days. This provisions remains unaffected by the above revision.

Once corrective actions have begun, the regulatory agency should evaluate their effectiveness and determine whether to continue, alter, or discontinue the actions. Because corrective actions are very site-specific such determinations cannot be made under the same uniform, preestablished schedule for all sites. It is the regulatory agency's responsibility, however, to assure that necessary decisions are rendered in a timely fashion. Acceptable plans for corrective actions should offer a high likelihood of achieving compliance with the standards. Furthermore, corrective actions which, once begun, show inadequate promise of achieving compliance should result in the regulatory agency's promptly disallowing the addition of new tailings to a noncomplying tailings pile.

5. Nonhazardous Materials

Comments were received on two matters regarding the contamination of ground water by nonhazardous materials. (They include chlorides, sulfates, manganese, and total dissolved solids, among others.) At high concentrations, these materials can make water unfit for use for other than health related reasons.

One view of these materials held that several of them are more mobile than hazardous materials. Thus, they precede the hazardous material in contaminating ground water. Ground water monitoring for these materials allows the prediction of future ground water contamination by hazardous materials. This detection scheme might therefore provide an early warning of ground water con-

tamination and allow early corrective actions to be taken, thereby effectively preventing ground contamination by hazardous materials.

EPA agrees with this comment. Analyzing water samples for the substances from tailings that are expected to be most mobile in a given ground water environment is a very useful feature of site-specific monitoring requirements. We note that § 264.98 already contains such a requirement and that the implementing regulatory agencies may be expected to establish such (or comparable) requirements.

A second view held that much of the ground water in the Western States is already contaminated with nonhazardous materials to an extent that it is unsuitable for use. These are primarily shallow aquifers (or uppermost aquifers) which would be the first to be contaminated by tailings materials. Since these ground waters are already contaminated, the argument goes, there is no need to prevent additional contamination.

This comment would require changing the ground water protection policy EPA has established for hazardous wastes under the SWDA rules. UMTRCA requires standards for tailings to be consistent with the SWDA standards. EPA has already considered the views expressed in these comments when it established its policy under the SWDA (47 FR at 32286, July 26, 1982). We do not think this rulemaking for byproduct materials is an appropriate forum in which to reconsider EPA's policies for hazardous wastes.

6. Neutralization of Tailings

Some commenters recommended that EPA require neutralization of tailings as a method to protect ground water. Neutralization is chemical treatment that would make the tailings neither acid nor alkaline. When tailings are neutralized many hazardous constituents are taken

out of solution and thereby are less prone to move through the earth and into ground water.

An EPA study of tailings neutralization in 1980, discussed in the FEIS, identified several issues regarding neutralization. First, some of the hazardous constituents in tailings form complex compounds that remain in solution over wide ranges of acidity and alkalinity. Selenium, arsenic, and molybdenum—all constituents of tailings—are particularly troublesome in this regard. Adequate control would require careful operation of the neutralization process. Second, the costs of neutralizing the tailings are significant, about the same as installation of a liner. Most of the cost is due to the need for a sludge storage lagoon. Finally, neutralization would not preclude the need for a liner.

The structure of regulation established by UMTRCA consists of generally applicable environmental standards established by EPA and regulations to implement these by NRC. Requirements for specific control methods, such as neutralization, are left to the implementing agency, to be used, as required, to ensure that EPA's general standards are satisfied. In view of the above, EPA has concluded that a standard requiring neutralization of tailings is inappropriate.

D. Procedural Issues

1. Molybdenum and Uranium Improperly Listed Under SWDA Requirements

Comments were received stating EPA improperly proposed listing molybdenum and uranium as hazardous constituents, because SWDA listing procedures were not followed.

EPA listed molybdenum and uranium as hazardous constituents only for purposes of controlling uranium and thorium byproduct materials. EPA does not intend in

this rulemaking to add molybdenum and uranium to the SWDA list of hazardous constituents, 40 CFR part 261, Appendix VIII. Therefore, the procedure we followed is proper. Clarification of this matter has been added to § 192.32(a)(2) of the final standard.

2. Inclusion of Thorium in the Standards

Several commenters pointed out that the DEIS contained no background supporting information for the thorium standards (Subpart E) and recommended deleting the thorium standards from this rule. Commenters also stated that there are significant differences in the physical and chemical characteristics and the radiological risk between uranium and thorium. They concluded, therefore, the EPA should not substitute the same requirements for thorium as for uranium as was proposed.

The FEIS contains appropriate discussions of thorium and a review of the implications of the radiological differences between thorium and uranium for the level of protection provided, the cost of control, and the feasibility of implementation of these standards. These effects are sufficiently small for EPA to conclude that the thorium standards should be promulgated as proposed.

IV. Regulatory Impact Analysis

Under Executive Order 12291, EPA must judge whether a regulation is "Major" and therefore subject to the requirement of a Regulatory Impact Analysis. We have not classified this rule as major, since it will not cause significantly large incremental costs above those which must be incurred in the absence of these regulations. We have prepared a Regulatory Impact Analysis (RIA), however, since there are wide variations in views on the extent of needed environmental controls in the uranium industry.

A. Benefit-Cost Analysis

The RIA examines the benefits and costs of selected alternative disposal standards, for both existing and new tailings piles. As discussed earlier, most of the benefits of tailings disposal cannot be quantified. The benefit we are best able to estimate is the number of lung cancer deaths avoided by controlling the radon emanation from tailings piles. Since the other benefits of disposal—prevention of misuse, ground water protection and prevention of the surface spread of tailings—cannot be quantified (let alone monetized), we could not make a completely numerical determination, within the traditional benefit-cost analysis framework.

We first performed a partial benefit-cost analysis of alternative disposal standards by relating the disposal costs for each alternative to the health effect estimates for direct radon emissions alone. Although this analysis relates only one category of benefit to the entire cost of disposal, it provides useful results to the extent that these benefits are found to be greater than the total cost of control. Second, we performed a cost-effectiveness analysis of alternative standards which assigns different sets of arbitrary weights to the entire range of benefits of tailings disposal. To perform this analysis, we also developed an index which quantifies the relative effectiveness of the disposal methods in providing designated types of control which correspond to the benefit categories. The cost-effectiveness analysis does not address whether the cost increases of tighter controls are worth incurring. Rather, by examining the sensitivity of the results to different choices of weighting schemes for the various benefits, in addition to identifying at what level additional gains in effectiveness start becoming increasingly more expensive, it points out to what degree the choice of standards is sensitive to the relative importance assigned to different types of benefits. Based in part on these analyses, we have made a qualitative judgment that the societal bene-

fits of the standards outweigh the societal costs, considering the long-term continuing train of benefits to society from isolating these hazardous materials from man and the environment.

A range of alternatives was evaluated for protection of public health and the environment. These alternatives included a range of control methods from no control to high levels of control and are summarized below. They do not include different levels of ground water protection, since those requirements must be consistent with standards already established under the SWDA. However, the length of time ground water is expected to be protected is indicated in the assessment of benefits.

Brief descriptions of each alternative follow:

Alternative A. This is the "no standards" case and represents the reference case representing conditions if nothing is done. The piles would remain hazardous for a long time, taking about 265,000 years for the radioactivity to decay to 10 percent of current levels. The radon emission rate is estimated to be 400 pCi/m^2s from a typical pile. The background rate for typical soils is about 1 pCi/m^2s. The concentration of some toxic chemicals in the tailings is hundreds of times background levels in ordinary soils, so that the potential for contaminating water and land is present and continues indefnitely.

Alternative B. These are "institutional care" cases and represent situations in which maintenance is required to assure the standard is satisfied. B1 specifies no radon emission limit, but requires control of wind-blown tailings and gamma radiation. B2 specifies radon control limits of 60 pCi/m^2s and B3 specifies 20 pCi/m^2s; both require control of wind-blown tailings and gamma radiation.

Alternative C. These are "long-term passive control" cases and represent situations in which design is for

long-term protection using engineered, passive methods requiring no continued maintenance. The radon emission limits examined are:

C1 none
C2 60 pCi/m²s
C3 20 pCi/m²s
C4 6 pCi/m²s
C5 2 pCi/m²s

Disposal methods would be designed to be effective for 1000 years in this case, in addition to providing control of wind-blown tailings and gamma radiation.

Alternative D. These cases assume staged disposal. They do not require continued maintenance and achieve control similar to Alternative C, plus improved control of radon during operations at new tailings piles. The radon emission limits examined are:

D2 60 pCi/m²s
D3 20 pCi/m²s
D4 6 pCi/m²s
D5 2 pCi/m²s

Disposal methods would be designed to be effective for 1000 years in this case, in addition to controlling wind-blown tailings and gamma radiation. Further, additional control of radon is achieved during the operational period at new tailing piles through use of staged disposal.

The costs and the benefits for these alternatives are listed in the accompanying tables. We examined the cost per death avoided from radon emissions for alternative control levels from several viewpoints. This range of viewpoints included the length of time over which health effects should be related to costs and whether nationwide population effects should be included with regional population effects in making benefit-cost comparisons. We conclude that the incremental cost per radon death avoided at a 20 pCi/m²s emission limit is a reasonable expendi-

ture under all scenarios. The range of incremental costs per death avoided at this control level is from $130,000 (nationwide health effects estimated for 1000 years) to $2.5 million (regional health effects estimated for only 100 years). For the next, more stringent, level of control, 6 pCi/m²s, the incremental costs are also higher: $630,000 to $12 million per radon death avoided. These costs are more uncertain and more likely to have been underestimated. For the next, less stringent, level of control, 60 pCi/m²s, the incremental costs are lower: $70,000 to $1.4 million. Whether or not the expenditure for a control level is acceptable depends on one's view of the relevant factors to be considered in valuing the benefit stream. On a relative basis, the incremental cost increases by at least a factor of 5 for going from the 20 pCi/m²s limit to 6 pCi/m²s, and increase by only a factor of 2 for going from 60 pCi/m²s to 20 pCi/m²s.

The results of our cost-effectiveness analyses, which incorporate different weighting schemes for all the benefits of disposal, indicate that the incremental costs per unit of overall effectiveness are relatively insensitive to the choice of weighting of benefits. The cost-effectiveness of obtaining increased benefits beyond 60 pCi/m²s decreases monotonically by up to factors of two for each incremental level of control for all weighting schemes examined.

B. Economic Impact Analysis

In the RIA, we developed cases for analyzing the industry-wide costs and economic impacts associated with tailings disposal methods assumed to be required for compliance with the alternative standards. Each case represented a different combination of disposal methods applied to both existing and new tailings. The estimated economic impacts include potential mill closures (on a model mill basis) and uranium price increases. We estimated the impacts for each case according to different financial

scenarios and different assumptions on the ability of companies to pass-through tailings disposal costs to their customers. The results from this analysis are used to represent the costs and impacts of the proposed standards.

We estimate that compliance with the standards, if other regulatory requirements did not exist, would cost the uranium milling industry about 260 million dollars for all tailings which exist today at licensed sites. If we include all those tailings which we estimate will be generated by the year 2000, based on recent DOE projections, the total cost to the uranium milling industry would be from 310 to 540 million dollars. These costs are present worth estimates (discounted at a 10 percent rate) expressed on a 1983 constant dollar basis. The range in cost is due to different assumptions on what actions are needed to meet requirements for ground water protection for new tailings at existing mills.

We estimate that increases in the price of uranium could range from 2 to 7 percent. In light of the currently poor economic condition of the industry and the threat of foreign competition, it is unlikely that mills will be able to pass through substantial portions of the disposal costs. Using our models and under the assumption of an average cash flow, we estimate that if mills are forced to absorb the entire cost of disposal, no mills would cease operation due to these standards. Under the conditions of no pass-through and lower cash-flow, one small model mill may close. However, we estimate that this closure can be avoided with the limited price pass-through stated above.

These costs and economic impacts are not all attributable to these standards, since some of these costs would probably occur in the absence of these standards due to other regulatory requirements at most sites. These include existing NRC licensing regulations and requirements established by agreement States, and regulations required under Section 84(a) (1) and (3) of UMTRCA.

We did not estimate the costs imposed by these other requirements because that would require a site-specific investigation and these requirements have been continuously changing in the past few years (mostly toward more stringent requirements). Therefore, we could only estimate the upper bounds of cost and economic impacts imposed by these standards, and could not estimate the net impact of the standards.

This regulation was submitted to the Office of Management and Budget for review as required by Executive Order 12291. We believe the analysis discussed above complies with the intent of the Order. Any comments from OMB to EPA and any EPA response to those comments are available for public inspection at the docket cited above under "ADDRESSES."

C. Regulatory Flexibility Analysis

This regulation would not have a significant impact on a substantial number of small entities, as specified under Section 605 of the Regulatory Flexibility Act (RFA). Therefore, we have not performed a Regulatory Flexibility Analysis. The basis for this finding is that of the 27 licensed uranium mills, only one qualifies as a small entity and this mill will not be impacted by the standards. Almost all the mills are owned by large corporations. Three of the mills are partly-owned by companies that could qualify as small businesses, according to the Small Business Administration generic small entity definition of 500 employees. However, under the RFA, a small business is one that is independently owned and operated. Since these three mills are not independently owned by small businesses, they are not small entities.

D. OMB Regulations on the Paperwork Reduction Act

This rule does not contain any information collection requirements subject to OMB review under the Paperwork Reduction Act of 1980 U.S.C. 3501, et seq.

TABLE I—COSTS OF ALTERNATIVE STANDARDS FOR TAILINGS CONTROL TO THE YEAR 2000 (MILLIONS OF 1983 DOLLARS)

Alternative standard	Present Worth Costs (10 percent discount rate)[a]		
	Existing tailings	Future tailings	Total cost
A	0	1	1
B1	117	83	200
B2	192	95	287
B3	256	111	367
C1	115	95	210
C2	192	112	304
C3	260	128	388
C4	336	146	482
C5	403	165	568
D2	192	156	348
D3	260	160	430
D4	336	186	522
D5	403	204	607

[a] These cost estimates assume that two-thirds of the future tailings generated at existing mills will be placed in existing impoundments and the other one-third will be placed in new, lined, impoundments. We assume that the average radium contents of existing and future tailings is 400 pCi/g. These costs are our best estimates, but their uncertainty increases as the level of required radon control increases.

TABLE II—BENEFITS OF ALTERNATIVE STANDARDS FOR TAILINGS CONTROL TO THE YEAR 2000 [a]

Stabilization			Radon Control			Water protection
				Deaths avoided		
Alternative standard	Chance of misuse	Erosion avoided (y)	Maximum risk [b] of lung cancer (percent reduction)	First 100 years	Total	longevity (y)
A	Very likely	0	2 in 10^2 (0)	0	0	0
B1	Likely	Hundreds	1 in 10^2 (50)	300	1,000	100
B2	Less likely	do	4 in 10^3 (80)	480	1,500	100
B3	do	do	1 in 10^3 (95)	570	2,000	100
C1	Likely	Thousands	1 in 10^2 (50)	300	Thousands	100
C2	Less likely	do	4 in 10^3 (80)	480	Many thousands	Hundreds
C3	Unlikely	do	1 in 10^3 (95)	570	Tens of thousands	1,000
C4	Very unlikely	Many thousands	3 in 10^4 (98.5)	590	do	> 1,000
C5	do	do	1 in 10^4 (99.5)	597	do	> 1,000
D2	Unlikely	Thousands	4 in 10^3 (80)	480	Several thousands	1,000
D3	do	Many thousands	1 in 10^3 (95)	570	Tens of thousands	> 1,000
D4	Very unlikely	do	3 in 10^4 (98.5)	590	do	> 1,000
D5	do	do	1 in 10^4 (99.5)	597	do	> 1,000

[a] These estimates include the benefits resulting from control of 26 existing piles and 9 projected new piles. No credit is taken for any engineering safety factors incorporated to provide the required "reasonable assurance" of conformance.

[b] Lifetime risk of fatal cancer to an individual assumed to be living 600 meters from center of a model tailings pile.

2003

This standard is promulgated on the date signed.

List of Subjects in 40 CFR Part 192

Air pollution control, Radiation protection, Hazardous materials, Uranium, Environmental protection, Hazardous constituents, Groundwater protection, Radon, Radium, and Thorium.

Dated: September 30, 1983.

William D. Ruckelshaus,
Administrator.

In 40 CFR Chapter I, Part 192 is amended by adding Subparts D and E as follows:

PART 192—HEALTH AND ENVIRONMENTAL PROTECTION STANDARDS FOR URANIUM AND THORIUM MILL TAILINGS

* * * * *

Subpart D—Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended

Sec.

192.30 Applicability.
192.31 Definitions and Cross-references.
192.32 Standards.
192.33 Corrective Action Programs.
192.34 Effective Date.

Subpart E—Standards for Management of Thorium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended

192.40 Applicability.
192.41 Provisions.
192.42 Substitute Provisions.
192.43 Effective Date.

Authority: Sec. 275 of the Atomic Energy Act of 1954, 42 U.S.C. 2022, as added by the Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. 95-604, as amended.

* * * * *

Subpart D—Standards for Management of Uranium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended

§ 192.30 Applicability.

This subpart applies to the management of uranium byproduct materials under Section 84 of the Atomic Energy Act of 1954 (henceforth designated "the Act"), as amended, during and following processing of uranium ores, and to restoration of disposal sites following any use of such sites under Section 83(b)(1)(B) of the Act.

§ 192.31 Definitions and Cross-references.

References in this subpart to other parts of the Code of Federal Regulations are to those parts as codified on January 1, 1983.

(a) Unless otherwise indicated in this subpart, all terms shall have the same meaning as in Title II of the Uranium Mill Tailings Radiation Control Act of 1978, Subparts A and B of this part, or Parts 190, 260, 261, and 264 of this chapter. For the purposes of this subpart, the terms "waste," "hazardous waste," and related terms, as used in Parts 260, 261, and 264 of this chapter shall apply to byproduct material.

(b) *Uranium byproduct material* means the tailings or wastes produced by the extraction or concentration of uranium from any ore processed primarily for its source material content. Ore bodies depleted by uranium solution extraction operations and which remain underground do not constitute "byproduct material" for the purpose of this Subpart.

(c) *Control* means any action to stabilize, inhibit future misuse of, or reduce emissions or effluents from uranium byproduct materials.

(d) *Licensed site* means the area contained within the boundary of a location under the control of persons generating or storing uranium byproduct materials under a license issued pursuant to Section 84 of the Act. For purposes of this subpart, "licensed site" is equivalent to "regulated unit" in Subpart F of Part 264 of this chapter.

(e) *Disposal site* means a site selected pursuant to Section 83 of the Act.

(f) *Disposal area* means the region within the perimeter of an impoundment or pile containing uranium by product materials to which the post-closure requirements of § 192.32(b)(1) of this subpart apply.

(g) *Regulatory agency* means the U.S. Nuclear Regulatory Commission.

(h) *Closure period* means the period of time beginning with the cessation, with respect to a waste impoundment, of uranium ore processing operations and ending with completion of requirements specified under a closure plan.

(i) *Closure plan* means the plan required under § 264.112 of this chapter.

(j) *Existing portion* means that land surface area of an existing surface impoundment on which significant quantities of uranium byproduct materials have been placed prior to promulgation of this standard.

§ 192.32 Standards.

(a) *Standards for application during processing operations and prior to the end of the closure period.* (1) Surface impoundments (except for an existing portion) subject to this subpart must be designed, con-

structed, and installed in such manner as to conform to the requirements of § 264.221 of this chapter, except that at sites where the annual precipitation falling on the impoundment and any drainage area contributing surface runoff to the impoundment is less than the annual evaporation from the impoundment, the requirements of § 264.228(a)(2)(iii)(E) referenced in § 264.221 do not apply.

(2) Uranium byproduct materials shall be managed so as to conform to the ground water protection standard in § 264.92 of this chapter, except that for the purposes of this subpart:

(i) To the list of hazardous constituents referenced in § 264.93 of this chapter are added the chemical elements molybdenum and uranium,

(ii) To the concentration limits provided in Table 1 of § 264.94 of this chapter are added the radioactivity limits in Table A of this subpart,

(iii) Detection monitoring programs required under § 264.98 to establish the standards required under § 264.92 shall be completed within one (1) year of promulgation,

(iv) The regulatory agency may establish alternate concentration limits (to be satisfied at the point of compliance specified under § 264.95) under the criteria of § 264.94(b), provided that, after considering practicable corrective actions, these limits are as low as reasonably achievable, and that, in any case, the standards of § 264.94(a) are satisfied at all points at a greater distance than 500 meters from the edge of the disposal area and/or outside the site boundary, and

(v) The functions and responsibilities designated in Part 264 of this chapter as those of the "Regional Administrator" with respect to "facility permits" shall be carried out by the regulatory agency, except that exemptions of hazardous constituents under § 264.93 (b) and

(c) of this chapter and alternate concentration limits established under § 264.94 (b) and (c) of this chapter (except as otherwise provided in § 192.32(a)(2)(iv)) shall not be effective until EPA has concurred therein.

(3) Uranium byproduct materials shall be managed so as to conform to the provisions of:

(a) Part 190 of this chapter, "Environmental Radiation Protection Standards for Nuclear Power Operations" and

(b) Part 440 of this chapter, "Ore Mining and Dressing Point Source Category: Effluent Limitations Guidelines and New Source Performance Standards, Subpart C, Uranium, Radium, and Vanadium Ores Subcategory."

(4) The regulatory agency, in conformity with Federal Radiation Protection Guidance (FR, May 18, 1960, pgs. 4402-3), shall make every effort to maintain radiation doses from radon emissions from surface impoundments of uranium byproduct materials as far below the Federal Radiation Protection Guides as is practicable at each licensed site.

(b) *Standards for application after the closure period.* At the end of the closure period:

(1) Disposal areas shall each comply with the closure performance standard in § 264.111 of this chapter with respect to nonradiological hazards and shall be designed [1] to provide reasonable assurance of control of radiological hazards to

(i) Be effective for one thousand years, to the extent reasonably achievable, and, in any case, for at least 200 years, and,

(ii) Limit releases of radon-222 from uranium byproduct materials to the atmosphere so as to not exceed

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[1] The standard applies to design. Monitoring for radon-222 after installation of an appropriately designed cover is not required.

an average[2] release rate of 20 picocuries per square meter per second (pCi/m^{2}s).

(2) The requirements of Section 192.32(b)(1) shall not apply to any portion of a licensed and/or disposal site which contains a concentration of radium-226 in land, averaged over areas of 100 square meters, which, as a result of uranium byproduct material, does not exceed the background level by more than:

(i) 5 picocuries per gram (pCi/g), averaged over the first 15 centimeters (cm) below the surface, and

(ii) 15 pCi/g, averaged over 15 cm thick layers more than 15 cm below the surface.

§ 192.33 Corrective Action Programs.

If the ground water standards established under provisions of Section 192.32(a)(2) are exceeded at any licensed site, a corrective action program as specified in 264.100 of this chapter shall be put into operation as soon as is practicable, and in no event later than eighteen (18) months after a finding of exceedance.

§ 192.34 Effective date.

Subpart D shall be effective December 6, 1983.

TABLE A

	pCi/liter
Combined radium-226 and radium-228	5
Gross alpha-particle activity (excluding radon and uranium)	15

[2] This average shall apply to the entire surface of each disposal area over periods of at least one year, but short compared to 100 years. Radon will come from both uranium byproduct materials and from covering materials. Radon emissions from covering materials should be estimated as part of developing a closure plan for each site. The standard, however, applies only to emissions from uranium byproduct materials to the atmosphere.

Subpart E—Standards for Management of Thorium Byproduct Materials Pursuant to Section 84 of the Atomic Energy Act of 1954, as Amended

§ 192.40 Applicability.

This subpart applies to the management of thorium byproduct materials under Section 84 of the Atomic Energy Act of 1954, as amended, during and following processing of thorium ores, and to restoration of disposal sites following any use of such sites under Section 83 (b) (1) (B) of the Act.

§ 192.41 Provisions.

The provisions of Subpart D of this part, including §§ 192.31, 192.32, and 192.33, shall apply to thorium byproduct material and:

(a) Provisions applicable to the element uranium shall also apply to the element thorium;

(b) Provisions applicable to radon-222 shall also apply to radon-220; and

(c) Provisions applicable to radium-226 shall also apply to radium-228.

(d) Operations covered under § 192.32(a) shall be conducted in such a manner as to provide reasonable assurance that the annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as a result of exposures to the planned discharge of radioactive materials, radon-220 and its daughters excepted, to the general environment.

§ 192.42 Substitute provisions.

The regulatory agency may, with the concurrence of EPA, substitute for any provisions of § 192.41 of this

subpart alternative provisions it deems more practical that will provide at least an equivalent level of protection for human health and the environment.

§ 192.43 Effective date.

Subpart E shall be effective December 6, 1983.

APPENDIX E

UNITED STATES COURT OF APPEALS FOR THE TENTH CIRCUIT

SEPTEMBER TERM—October 30, 1985

Before Honorable William J. Holloway, Jr., Honorable Robert H. McWilliams, Honorable James E. Barrett, Honorable Monroe G. McKay, Honorable James K. Logan, Honorable Stephanie K. Seymour, Honorable John P. Moore, Circuit Judges, and Honorable Luther Bohanan *

Nos. 83-1014
83-1041
83-1206
83-1300

AMERICAN MINING CONGRESS, a Colorado corporation, *et al.*,
Petitioners,

v.

LEE M. THOMAS, ETC., *et al.*,
Respondents,

THE SIERRA CLUB, *et al.*,
Intervenors,

THE STATE OF WYOMING,
Amicus Curiae.

This matter comes on for consideration of Petitioners' petitions for rehearing and suggestions for rehearing in banc filed in the captioned causes.

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* District Judge of the United States District Court for the Western District of Oklahoma, sitting by designation.

Upon consideration whereof, the petitions for rehearing are denied by the panel to whom the cases were argued and submitted.

The petitions for rehearing having been denied by the panel to whom the cases were argued and submitted, and no member of the panel nor judge in regular active service on the Court having requested that the Court be polled on rehearing in banc, Rule 35, Federal Rules of Appellate Procedure, the suggestions for rehearing in banc are denied.

/s/ Howard K. Phillips
HOWARD K. PHILLIPS,
Clerk

APPENDIX F

UNITED STATES COURT OF APPEALS
FOR THE TENTH CIRCUIT

SEPTEMBER TERM—October 30, 1985

Before Honorable William J. Holloway, Jr., Honorable Robert H. McWilliams, Honorable James E. Barrett, Honorable Monroe G. McKay, Honorable James K. Logan, Honorable Stephanie K. Seymour, Honorable John P. Moore, Circuit Judges, and Honorable Luther Bohanan *

Nos. 83-2226
83-2227
83-2277
83-2504
84-1352
84-1908

AMERICAN MINING CONGRESS, *et al.*,
Petitioners,

v.

LEE THOMAS, ETC., *et al.*,
Respondent.

This matter comes on for consideration of petitioners' petitions for rehearing and suggestions for rehearing in banc filed in the captioned causes.

Upon consideration whereof, the petitions for rehearing are denied by the panel to whom the cases were argued and submitted.

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* District Judge of the United States District Court for the Western District of Oklahoma, sitting by designation.

The petitions for rehearing having been denied by the panel to whom the cases were argued and submitted, and no member of the panel nor judge in regular active service on the Court having requested that the Court be polled on rehearing in banc, Rule 35, Federal Rules of Appellate Procedure, the suggestions for rehearing in banc are denied.

/s/ Howard K. Phillips
HOWARD K. PHILLIPS,
Clerk

APPENDIX G

The Uranium Mill Tailings Radiation Control Act of 1978, Pub. L. No. 95-604, 92 Stat. 3021 (1978) (codified as amended at 42 U.S.C. § 2014 and scattered sections thereafter and at 42 U.S.C. §§ 7901-42), provides, in relevant part:

42 U.S.C. § 2022(a):

§ 2022. Health and environmental standards for uranium mill tailings

(a) Promulgation and revision of rules for protection from hazards at inactive or depository sites

As soon as practicable, but not later than October 1, 1982, the Administrator of the Environmental Protection Agency (hereinafter referred to in this section as the "Administrator") shall, by rule, promulgate standards of general application (including standards applicable to licenses under section 104(h) of the Uranium Mill Tailings Radiation Control Act of 1978 [42 U.S.C. 7914(h)]) for the protection of the public health, safety, and the environment from radiological and nonradiological hazards associated with residual radioactive materials (as defined in section 101 of the Uranium Mill Tailings Radiation Control Act of 1978 [42 U.S.C. 7911]) located at inactive uranium mill tailings sites and depository sites for such materials selected by the Secretary of Energy, pursuant to title I of the Uranium Mill Tailings Radiation Control Act of 1978 [42 U.S.C. 7911 et seq.]. Standards promulgated pursuant to this subsection shall, to the maximum extent practicable, be consistent with the requirements of the Solid Waste Disposal Act, as amended [42 U.S.C. 6901 et seq.]. In establishing such standards, the Administrator shall consider the risk to the public health, safety, and the environment, the environmental and

economic costs of applying such standards, and such other factors as the Administrator determines to be appropriate. The Administrator may periodically revise any standard promulgated pursuant to this subsection. After October 1, 1982, if the Administrator has not promulgated standards in final form under this subsection, any action of the Secretary of Energy under title I of the Uranium Mill Tailings Radiation Control Act of 1978 which is required to comply with, or be taken in accordance with, standards of the Administrator shall comply with, or be taken in accordance with, the standards proposed by the Administrator under this subsection until such time as the Administrator promulgates such standards in final form.

42 U.S.C. § 2022(b):

(b) Promulgation and revision of rules for protection from hazards at processing or disposal sites

(1) As soon as practicable, but not later than October 31, 1982, the Administrator shall, by rule, propose, and within 11 months thereafter promulgate in final form, standards of general application for the protection of the public health, safety, and the environment from radiological and nonradiological hazards associated with the processing and with the possession, transfer, and disposal of byproduct material, as defined in section 2014(e)(2) of this title, at sites at which ores are processed primarily for their source material content or which are used for the disposal of such byproduct material. If the Administrator fails to promulgate standards in final form under this subsection by October 1, 1983, the authority of the Administrator to promulgate such standards shall terminate, and the Commission may take actions under this chapter without regard to any provision of this chapter requiring such actions to

comply with, or be taken in accordance with, standards promulgated by the Administrator. In any such case, the Commission shall promulgate, and from time to time revise, any such standards of general application which the Commission deems necessary to carry out its responsibilities in the conduct of its licensing activities under this chapter. Requirements established by the Commission under this chapter with respect to byproduct material as defined in section 2014(e)(2) of this title shall conform to such standards. Any requirements adopted by the Commission respecting such byproduct material before promulgation by the Commission of such standards shall be amended as the Commission deems necessary to conform to such standards in the same manner as provided in subsection (f)(3) of this section. Nothing in this subsection shall be construed to prohibit or suspend the implementation or enforcement by the Commission of any requirement of the Commission respecting byproduct material as defined in section 2014(e)(2) of this title pending promulgation by the Commission of any such standard of general application. In establishing such standards, the Administrator shall consider the risk to the public health, safety, and the environment, the environmental and economic costs of applying such standards, and such other factors as the Administrator determines to be appropriate.

(2) Such generally applicable standards promulgated pursuant to this subsection for nonradiological hazards shall provide for the protection of human health and the environment consistent with the standards required under subtitle C of the Solid Waste Disposal Act, as amended [42 U.S.C. 6921 et seq.], which are applicable to such hazards: *Provided, however*, That no permit issued by the Administrator is required under this chapter or the Solid Waste Disposal Act, as amended [42 U.S.C. 6901 et seq.], for

the processing, possession, transfer, or disposal of byproduct material, as defined in section 2014(e)(2) of this title. The Administrator may periodically revise any standard promulgated pursuant to this subsection. Within three years after such revision of any such standard, the Commission and any State permitted to exercise authority under section 2021(b)(2) of this title shall apply such revised standard in the case of any license for byproduct material as defined in section 2014(e)(2) of this title or any revision thereof.

42 U.S.C. § 7901(a):

§ 7901. Congressional findings and purposes

(a) The Congress finds that uranium mill tailings located at active and inactive mill operations may pose a potential and significant radiation health hazard to the public, and that the protection of the public health, safety, and welfare and the regulation of interstate commerce require that every reasonable effort be made to provide for the stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings.